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# Agricultural Economics Research

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A Journal  
of the  
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# Agricultural Economics Research

A Journal of the U.S. Department of Agriculture • Economic Research Service

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# In This Issue

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“Let the data speak for themselves.” Both articles in this issue of *Agricultural Economics Research* address areas of research and analysis where this seemingly self-evident and noncontroversial statement is neither.

The first article, by Johnson and Baum, is best described as a statement of the current status of the continuing effort to develop and report a measure of U.S. farmers’ income that accurately reflects the economic well-being in the farm sector. The U.S. Department of Agriculture (USDA) has been annually reporting farm income since 1924, and the series has been criticized probably since that year, as irrelevant, conceptually obsolete, and based on inadequate data.

USDA has not ignored the criticisms, but its efforts to address perceived problems have been complicated by the widely varying types and sizes of American farms, fairly rapid technological and structural change on these farms, and widely varying needs for and uses of farm income estimates. The agricultural economics profession has made many contributions to the ongoing review and development of the accounts over the years. A complete list of contributors would be too lengthy for this column, but a list of recent noteworthy intellectual and conceptual contributors within USDA would be headed by Eldon Weeks and outside by former President James Bonnen of the American Agricultural Economics Association.

USDA’s ability to respond to suggested conceptual improvement has often been constrained by the

unavailability of appropriate data. Johnson and Baum report on a major USDA effort to address this problem with an annual probability-based survey that uses integrated replicate sampling to obtain the necessary information. This change is important in the ongoing development of the farm income accounts, but is one in which users of farm income statistics have a large stake. In the continuing effort to enhance the credibility of this much maligned, but widely used, economic series, has this shift to a greater reliance on a single annual survey been a successful step? Readers will have to answer that for themselves.

The second article, by Orden, presents an estimation technique, vector autoregression (VAR), which begins by selecting a set of variables perceived as relevant to an economic issue under investigation. No variable is assumed to be exogenous *a priori*, and no variable is excluded from the autoregressive equation for any variable. This “let the data speak for themselves” approach to economic analysis has its supporters; yet, it is criticized by more structurally oriented modelers. Aware of this controversy, Orden guides the reader through the development of his VAR model, highlighting both pitfalls and points of strength. He discusses and interprets his model and presents impulse response functions from the model. The article addresses all the enticingly relevant questions about agricultural-macroeconomic linkages. Again, I ask: Was this journey successful? Have the data spoken convincingly?

**Gerald Schluter**

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# Whole Farm Survey Data for Economic Indicators and Performance Measures

By James Johnson and Kenneth Baum\*

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## Abstract

The aggregate economic indicators and statistical series published by the U.S. Department of Agriculture provide insufficient information for decisionmakers requesting disaggregated analyses of farm industries, farm types, or farm sizes. However, this information can be obtained through the annual probability-based Farm Costs and Returns Survey, which uses integrated replicate sampling.

## Keywords

Economic indicators, Farm Costs and Returns Survey

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## INTRODUCTION

Users of agricultural data have become accustomed to a long history of published aggregate agricultural statistics. The Bureau of the Census, through the quinquennial *Census of Agriculture*, and the U.S. Department of Agriculture (USDA), through periodic surveys conducted by the National Agricultural Statistics Service (NASS)<sup>1</sup>, have provided most aggregate farm sector data on the number of farms, the characteristics of farms and their operators, land use, commodity production, disposition and value, inventories, certain purchased inputs and other resource use, prices paid and received, and limited data on labor hours and wages (2).<sup>2</sup>

Although a variety of primary and secondary data series is available for economic analysis, the agricultural data base continues to contain major inadequacies. Little attention has been given to "our . . . investment in the conceptualization of agricultural data systems and to developing the entirely new systems of data needed to contend with problems of a rapidly changing economy and way of life" (1). The technical, financial, and managerial organization of farming is undergoing dramatic changes. Yet, the economic data base for agriculture remains focused

largely on the concept of a homogeneous farming sector. Information about the economic performance and well-being of different types and sizes of farms and other distributional issues may, therefore, not be reliable when derived from aggregate statistics (13).

A second, more practical problem is the lack of appropriate data to implement current aggregate economic indicator concepts and distributional indicators either now developed or under development. For example, a large number of the components of the farm income and balance sheet statistics published by the Economic Research Service (ERS) are benchmarked to socioeconomic data collected through the *Census of Agriculture* and specialized Census followup surveys, many of which have been discontinued. Thus, portions of our agricultural economic statistics series have been either without a benchmark data source, such as off-farm income, or with a benchmark that, at best, will soon be more than a decade old.

Two important issues relate to our inability to fully use survey data to develop and improve research related to the well-being and performance of agricultural subsectors. First, although existing published data are useful, even critical, to most economic analyses, these cross-tabulations are often inadequate to meet specialized analytical needs or to create new or nontraditional economic indicators. This inadequacy occurs because many of the policy or research problems to be addressed focus on micro-economic issues and require data that focus on sub-

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<sup>1</sup>Formerly the Statistical Reporting Service.

<sup>2</sup>Italicized numbers in parentheses refer to items in the References at the end of this article.

sets of the farm-sector population with particular characteristics. And, although data are published for major farm subsectors and by major farm characteristics, similar data are not available giving joint distributions of these and other characteristics such as size of farm, financial structure of the business, and socioeconomic characteristics of the operator (10).

We are also unable to match data from multiple survey sources to provide an integrated perspective on the economic performance of the farm sector. Surveys are conducted at different times and by different organizations for different purposes. The population to be surveyed also changes. Moreover, if surveys are conducted with different sampling procedures, analytical questions may be raised about the use of multi-source, multi-time-frame data either to develop economic performance measures or to analyze changes in economic structure or behavior.

Over the last decade, and especially over the last 3 years, ERS has been reviewing the conceptual foundations and empirical procedures in the published income, cost of production, balance sheet, and productivity accounts. We have also been reviewing the primary surveys conducted by ERS and NASS to support enterprise costs, productivity, farm income, and balance sheet accounts. Over the last several years, USDA has revised enterprise (cost-of-production) and whole-farm (income) survey questionnaires, sampling methodology, and sample sizes. These revisions will provide a data base sufficient to allow disaggregation of the national accounts to provide statistically reliable data on farms by type, size, and region. USDA has also designed modular questionnaires to easily accept data changes in income, finance, or cost concepts so that future changes in data needs will not cause major changes in survey design.

## A Historical Perspective

The quality and use of agricultural data embrace both conceptual development and empirical measurement. The research community, both within and outside USDA, has focused considerable attention for many decades on the quality and potential analytical usefulness of a national agricultural data system for the farm sector to support policy, production, finance, and farm management research.

## Conceptual Development

The Committee on Economic Statistics of the American Agricultural Economics Association stated in 1972 that, with continued structural transformations in agriculture and rural life, "theoretical concepts around which we have constructed our data systems grow progressively more obsolete—so obsolete that minor tinkering with each Census or survey no longer seems to bridge the basic inadequacy of the ideas being quantified" (1). The Committee left the profession with an ambitious agenda of topics focused on reducing data collection obsolescence. As Lee noted, however, the Committee did not go beyond listing issues that established "the dimensions of social data needs . . ." (6). However, several years later, in his presidential address, Bonnen moved the profession well beyond listing data needs by providing insight into conceptual obsolescence in data and by developing a paradigm for an agricultural information system (3).

During the sixties and seventies, USDA economists also studied conceptual and empirical data system issues, the latter through statistical redesign of sampling frames for crops and livestock. "The cornerstone for a new farm statistical structure in the United States was laid in 1966 when the Statistical Reporting Service of the USDA put a probability sampling scheme into operation in the 48 contiguous States" (14). Beginning in 1970, NASS used list sampling frames to supplement area sampling frames, thus retaining a probability survey design while introducing the "multiframe" sampling procedure into USDA surveys. In 1976, the "multiframe" survey approach was extended to surveys used to collect economic data.

ERS staff has researched the economic concepts and accounting procedures underlying the cost and income accounts published by the Agency. Weeks reviewed aggregate data series published for agriculture and explored alternative approaches to shift the conceptual emphasis in agricultural data toward the same procedures and rationale as the national income and product accounts published by the U.S. Department of Commerce (17). A task force on Farm Income and Capital Accounting was established in 1972 and again in 1974 to inventory the basic income and accounting work done in ERS, appraise

conceptual content and estimation procedures, and provide recommendations for program improvement (15, 16).

Among the 1974 task force conclusions was a recommendation that "net income of farms" be substituted for "net income of farm operations." This recommendation entailed a conceptual shift in the agricultural accounts, meaning that the farm would be measured as a business enterprise or establishment, rather than as a family household or consuming unit.

ERS has also moved toward implementing the conceptual arguments advanced during the previous decade. Revised income accounts first published in 1980 were based on "the concept of separating the measurement of the economic viability of the production units of the farm sector from the well-being of the farm operator families" (11). ERS developed a farm production transaction account to measure the income from production establishments so that the value added by the farm production sector can be distributed to the institutions or individuals who control the sector's resources. In this account, the residual is a return to operators. In 1983, ERS also revised cost-of-production accounts by implementing a conceptually stronger methodology and presentation format. The revised cost-of-production budgets measure cash receipts, cash and economic costs of production, and cash-flow measures for enterprises, and they provide a basis for determining the longrun return to farm assets.

### **Data Problems and the Economic Indicator Accounts**

The current data series are increasingly recognized as inadequate for analyzing industry-specific or distributional issues. As Kallek stated in 1981, "There is a growing realization that farms are increasingly different, they have different resource characteristics, needs, and goals. Part-time farms differ from full-time farms as do dairy farms from cash grain farms" (5).

We do not discuss all the data voids or inadequacies that exist for the various indicator accounts in this article. These problems must eventually be addressed, however, either through primary surveys or from secondary data sources, such as administrative data provided by other USDA agencies, including the

Farmers Home Administration, or other institutions, such as the Farm Credit System. We will highlight a few specific conceptual and empirical data issues to illustrate why ERS is concerned with the appropriateness of its own data collection efforts (9).

First, ERS uses production, marketing, and price data obtained from NASS to estimate most components of gross receipts for the farm sector as a whole for most commodities. We are concerned about coverage, however, and we have discussed with NASS ways to improve aggregate estimates of "minor" or specialty crop marketings important to a particular locality, but perhaps less important either to an individual commodity or on a national basis. If these commodities are not properly included in the accounts, gross receipts can be understated.

Second, we include an estimate of the value of home consumption of commodities produced on farms in estimates of net income to help fully account for the use of inputs that are included in sector expenses. Reliable home consumption data exist for livestock, but data for fruits, vegetables, and other crops have not been available for several years. A benchmark has simply been adjusted to reflect changes that could affect consumption. We revised our 1985 surveys to collect consumption value estimates, and we will evaluate these data to determine their usefulness in estimating these accounts.

Third, estimates of the value of the change in inventories are of critical concern. To estimate sector net income from production activities during a specified calendar year, we either add to or subtract from gross income an estimate of the value of the change in physical quantity. We estimate the change in physical quantity stored by subtracting marketings and onfarm use from production. Data have not been collected on the quantity of feed, hay, and other output fed on farms where produced, and benchmark estimates are several years old. Meanwhile, changes in the operating characteristics of the feed-livestock subsector influence estimates of the quantity of grain sold versus the quantity fed, and these changes affect the overall estimates of cash receipts. To address these data problems, USDA added questions to sector surveys conducted for 1984 and 1985. The results from these questions will be used to determine the use of farm-produced feed and to derive a more reliable estimate of inventory adjustments and cash receipts.

Fourth, we have also begun to research and review the gross receipts accounts to determine if additional income sources have been inadvertently omitted. For example, we now charge interest paid on machinery and real estate as an expense, but we do not treat the sale of machinery as capital account transactions or as an income source to the business. Similarly, wages paid to family members are counted as expenses, which is proper for the business, but these wages are not also counted as income when total family income is being measured. Any measure of family well-being is probably understated without consideration of these wages, which amounted to about \$3 billion in 1984.

Fifth, we still have not addressed several conceptual and empirical problems. While most expense estimates may have an adequate underlying data base for any particular item at an aggregate level, we do not know how expenses differ for different types of farm businesses. One conceptual issue we are studying is the need to separate livestock purchased for capital account uses from livestock purchased for resale. This separation would prevent overstating production expenses and understating capital expenditures. Survey data from 1984 indicate that about 34 percent of livestock purchases were for breeding stock.

Sixth, interest expense estimates obtained through sector surveys, including the Census of Agriculture, differ significantly from estimates developed from the use of institutional debt and a calculated average interest rate. Survey data, including the 1982 Census of Agriculture, suggest that cash interest expenses may be overstated in the USDA accounts. Moreover, the accounts should distinguish short-term production loans from longer term loans and farm versus household shares. Financial data which more clearly distinguish between operator and landlord debt holdings and debt for farm and nonfarm business purposes (even if the debt were secured by farm collateral, especially real estate) would greatly improve the accuracy and usefulness of both the income and balance sheet accounts.

Seventh, purchased but unused fuel, seed, fertilizer, and feed are expense items that probably should be included in an operating input inventory because many farmers prepurchase and stock these items for later use. To the extent that inputs are purchased but not consumed, income and balance sheet ac-

counts could be incorrectly estimated and net income would be understated during the year of purchase and overstated during the year of use. We collected data to provide an operating input inventory estimate the first time for 1984. Our initial estimate indicated that farmers spent about \$1.6 billion on inputs still on hand at the end of the calendar year.

Because we do not know the year of purchase, we will need additional data to track annual changes so that the change in input inventories can be measured and added to or subtracted from gross income and assets measures. We are also collecting data to improve estimates of the costs associated with marketing, hiring, machinery, and custom-work services. These expense items were probably not too significant when the income accounts were being developed many years ago, but they have become far more significant during the past decade.

Finally, we need additional data to improve the cost-of-production (COP) estimates. Specialized farm COP surveys have been used since 1974 to determine application rates, machinery operations, buildings, and other technical information. Because these commodity-specific surveys were taken every 4-5 years, cost estimates are primarily updated between survey years only for changes in input prices. USDA economists derive labor, fuel, lubrication, and repair costs of machinery using engineering equations and relationships derived in the sixties. We should ideally collect data to update all enterprise cost items annually based on a combination of quantity and price changes instead of input price changes only. A more important shortcoming of previous (pre-1984) crop COP surveys is that they were conducted with a non-probability sampling design. We have consequently not been able to use these data to conduct analyses of enterprise costs concerning the portion of production at certain cost levels, farm size, commodity specialization, and other operating characteristics useful in understanding differences in farm efficiency, costs, and returns. Many of these enterprise cost relationships will be addressed with data collected in subsequent surveys.

## **Data Needs and Survey Plans**

Prior to 1984, ERS and NASS jointly conducted two independent national surveys: the Farm Production Expenditures Survey (FPES) and the Cost-of-Produ-

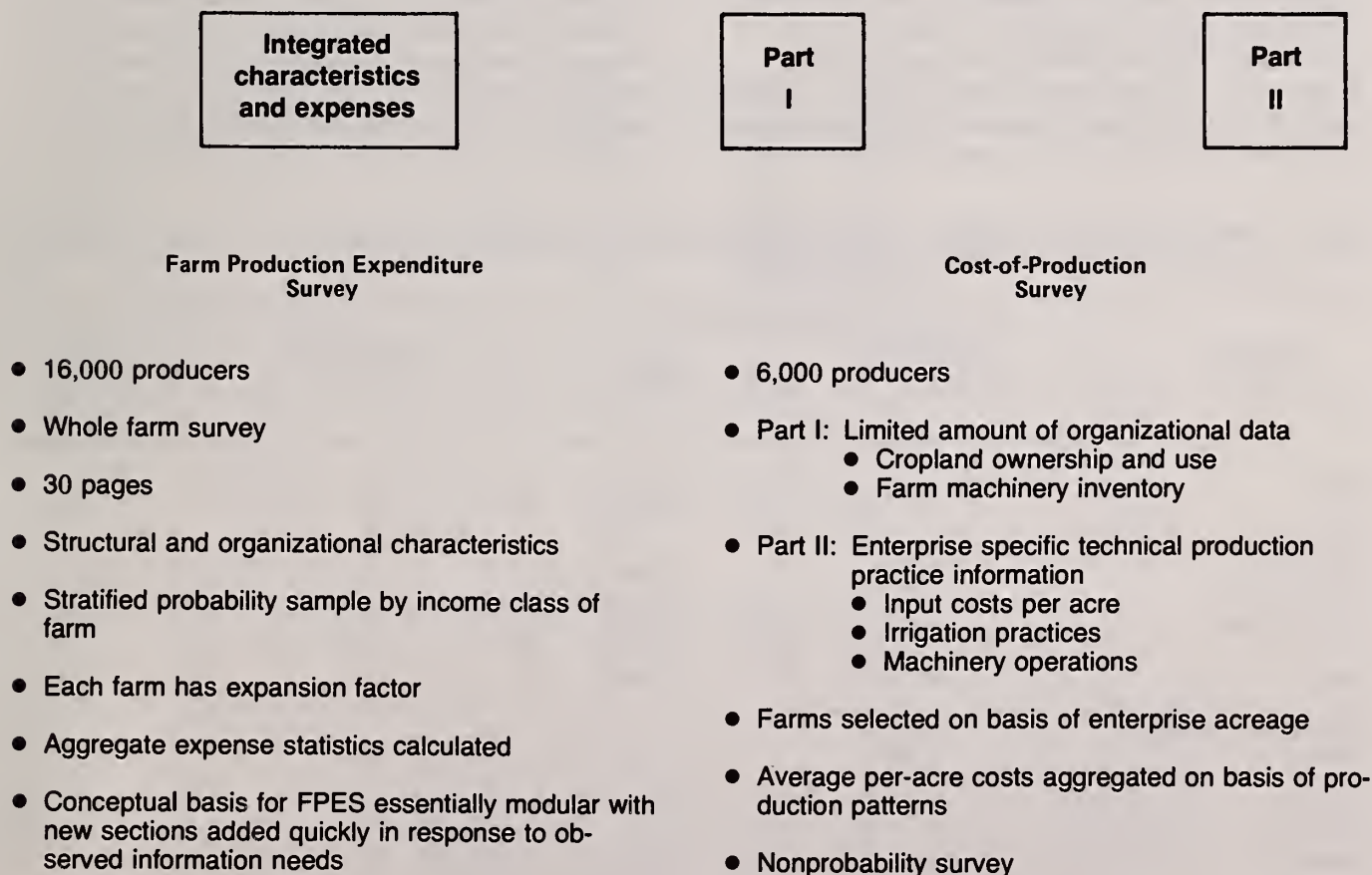
tion Survey (COPS). ERS has spent about \$2.2 million on the FPES and COPS, allowing a survey sample sufficient to yield 3,000-4,000 usable COP questionnaires and 7,000-8,000 usable FPES questionnaires annually. The FPES was a probability-based, whole-farm survey collecting total farm expense and receipt data used in preparing national economic indicator series. The COPS collected enterprise-specific technical data by selecting farms proportional to the acreage of selected enterprises. Although similar information was gathered from both surveys, the COPS data could not be used to supplement the FPES, and the FPES could not be used to supplement COPS data (fig. 1). Thus, from the perspective of either survey, much information

was irrelevant; from the perspective of distributional analysis, only a portion of the farm business information base needed was available. Because the surveys' data could not be merged, neither survey provided a very reliable source of cross-tabulated data. Even at the national level, some of the data had relatively large measures of dispersion (coefficients of variation for the 1981 FPES ranged from 8.2-15.0 percent, for example).

Maintaining this dual-track enterprise and whole farm survey system caused several other major problems. First, conducting two independent surveys increased overhead costs for survey schools and costs for data collection on those farms in both surveys.

Figure 1

## FY 1978-79 Surveys



Second, when the same farm is covered in both surveys, the two surveys competed for producers' time in supplying information; enumerators made multiple visits asking for some of the same data. Third, we were unable to establish data relationships between enterprise activities and the farm business. Finally, we were also unable to answer questions about data reliability, dispersion, and variance of economic indicator measures for different types and sizes of farms by ownership, region, and other characteristics.

Thus, beginning in 1982, ERS and NASS discussed ways to merge the FPES and COPS into a probability-based Farm Costs and Returns Survey (FCRS). This completely integrated whole-farm and commodity-specific survey uses replicated samples for specific detailed (technical or critical problem) information. The FCRS addresses five objectives: (1) estimating COP budget items on a probability basis; (2) redesigning the COPS questionnaires to include whole-farm data, thus providing a link to the previously conducted FPES; (3) enhancing farm financial data; (4) enhancing data collection, editing, and review procedures to reduce overhead costs; and (5) increasing the involvement and technical support

for the survey from various data collection and analysis units within ERS and NASS. The newly structured survey is expected to have a sample size of about 24,000 farm operators annually and to have coefficients of variation (CV) less than 4 percent for major expense categories and 10 percent for others.

Because the new FCRS survey is probability-based and has a relatively large sample, we can conduct distributional analyses of operating costs, returns, and financial characteristics by size and type of farm by major producing regions (tables 1 and 2). The CV's for total expenses were dropped to 2 percent in the 1984 survey. Even major components of expenses now carry a CV of about 4 percent or less. More important, the last column of table 1 shows the effect of the survey merger on the quality of the aggregate expense data used to estimate farm income. CV's were substantially reduced; the CV for total expenses dropped from 2.0 percent to 1.7 percent. Another major effect is the ability to develop more statistically reliable cross-tabulations (table 2). Estimated CV's for major data items for any of the farm size classes are about 6 percent or less. Those items with CV's greater than 5-6 percent are items that occur sporadically and would not be expected on a large

**Table 1—1984 Farm Costs and Returns Survey: Multiple-frame expansions and coefficients of variation, selected items, expenditure version and all versions**

| Expense                  | Multiple-frame expansions |              | Coefficients of variation |              |
|--------------------------|---------------------------|--------------|---------------------------|--------------|
|                          | Expenditure version       | All versions | Expenditure version       | All versions |
|                          | <i>Million dollars</i>    |              | <i>Percent</i>            |              |
| Total                    | 129,001                   | 131,514      | 2.0                       | 1.7          |
| Livestock and poultry    | 33,272                    | 34,325       | 3.6                       | 3.4          |
| Farm services            | 25,411                    | 25,796       | 2.5                       | 1.9          |
| Feed                     | 18,145                    | 18,341       | 4.1                       | 3.5          |
| Wages and contract labor | 11,125                    | 11,542       | 3.6                       | 3.3          |
| Fertilizer               | 8,817                     | 9,144        | 2.5                       | 2.1          |
| Interest                 | 13,474                    | 13,559       | 2.5                       | 2.0          |
| Fuels and energy         | 6,996                     | 6,951        | 2.3                       | 1.8          |

Table 2—Farm financial information by acres operated, 1984<sup>1</sup>

| Item                                        | Up to 100 acres |                  |                          | 101 to 250 acres |                  |                          | 251 to 500 acres |                  |                          | 500 to 1,000 acres |                  |                          |
|---------------------------------------------|-----------------|------------------|--------------------------|------------------|------------------|--------------------------|------------------|------------------|--------------------------|--------------------|------------------|--------------------------|
|                                             | Total           | Average per farm | Coefficient of variation | Total            | Average per farm | Coefficient of variation | Total            | Average per farm | Coefficient of variation | Total              | Average per farm | Coefficient of variation |
|                                             | 1,000 dollars   | Dollars          | Percent                  | 1,000 dollars    | Dollars          | Percent                  | 1,000 dollars    | Dollars          | Percent                  | 1,000 dollars      | Dollars          | Percent                  |
| Gross farm income                           | 14,705,311      | 22,908           | 5.30                     | 15,824,779       | 41,229           | 4.46                     | 21,891,850       | 74,096           | 3.79                     | 27,186,532         | 137,981          | 4.40                     |
| Livestock and crop marketings               | 13,565,228      | 21,132           | 5.58                     | 14,621,430       | 38,094           | 4.63                     | 20,553,396       | 69,565           | 3.88                     | 25,264,880         | 128,228          | 4.40                     |
| All Government farm payments                | 87,985          | 137              | 15.14                    | 215,292          | 561              | 10.79                    | 427,451          | 1,447            | 7.88                     | 766,071            | 3,888            | 6.91                     |
| Other farm income                           | 1,052,098       | 1,639            | 10.52                    | 988,057          | 2,574            | 11.50                    | 911,003          | 3,083            | 8.39                     | 1,155,581          | 5,865            | 16.11                    |
| Operating expense less interest             | 13,355,793      | 20,806           | 5.19                     | 12,597,440       | 32,821           | 4.59                     | 17,099,690       | 57,876           | 4.04                     | 19,867,383         | 100,834          | 4.10                     |
| Interest paid on real estate debt           | 1,119,804       | 1,744            | 6.26                     | 893,952          | 2,329            | 5.83                     | 1,350,134        | 4,570            | 5.90                     | 1,593,421          | 8,087            | 5.26                     |
| Interest paid on operating loans            | 373,041         | 581              | 8.41                     | 582,772          | 1,518            | 6.61                     | 1,057,922        | 3,581            | 5.59                     | 1,413,695          | 7,175            | 4.74                     |
| Net cash income                             | -143,326        | -223             | 229.03                   | 1,750,615        | 4,561            | 14.81                    | 2,384,104        | 8,069            | 15.54                    | 4,312,033          | 21,885           | 13.98                    |
| Off-farm income                             | 12,237,494      | 19,064           | 6.07                     | 5,203,618        | 13,557           | 6.13                     | 5,281,335        | 17,875           | 29.62                    | 1,862,346          | 9,452            | 9.54                     |
| Farm family income                          | 12,094,167      | 18,841           | 6.10                     | 6,954,233        | 18,118           | 5.88                     | 7,665,439        | 25,945           | 20.28                    | 6,174,380          | 31,337           | 10.20                    |
| Total farm debt                             | 13,017,852      | 20,279           | 5.41                     | 13,947,859       | 36,339           | 5.81                     | 22,504,627       | 76,170           | 5.12                     | 26,710,272         | 135,563          | 4.41                     |
| Total farm assets                           | 90,697,745      | 141,291          | 4.31                     | 81,456,714       | 212,224          | 3.70                     | 96,739,018       | 327,424          | 3.56                     | 99,762,757         | 506,329          | 4.12                     |
| Debt/asset ratio                            | na              | 14               | 4.55                     | na               | 17               | 5.46                     | na               | 23               | 4.14                     | na                 | 27               | 3.68                     |
| Asset turnover ratio                        | na              | 15               | 5.34                     | na               | 18               | 4.33                     | na               | 21               | 3.20                     | na                 | 25               | 3.84                     |
| Fixed asset turnover ratio                  | na              | 16               | 5.46                     | na               | 20               | 4.57                     | na               | 25               | 3.44                     | na                 | 30               | 4.09                     |
| Ratio of interest to total cash expense     | na              | 10               | 5.18                     | na               | 10               | 4.38                     | na               | 12               | 3.51                     | na                 | 13               | 3.28                     |
| Ratio of off-farm income to net cash income | na              | -8,538           | 198.47                   | na               | 297              | 15.96                    | na               | 222              | 35.84                    | na                 | 43               | 16.91                    |

See footnotes at end of table.

Continued

Table 2—Farm financial information by acres operated, 1984<sup>1</sup>—Continued

| Item                                        | 1,001 to 2,000 acres |                  |                          | Over 2,000 acres |                  |                          | All acreage classes |                  |                          |
|---------------------------------------------|----------------------|------------------|--------------------------|------------------|------------------|--------------------------|---------------------|------------------|--------------------------|
|                                             | Total                | Average per farm | Coefficient of variation | Total            | Average per farm | Coefficient of variation | Total               | Average per farm | Coefficient of variation |
|                                             | 1,000 dollars        | Dollars          | Percent                  | 1,000 dollars    | Dollars          | Percent                  | 1,000 dollars       | Dollars          | Percent                  |
| Gross farm income                           | 19,589,235           | 189,871          | 5.21                     | 20,800,828       | 286,769          | 4.79                     | 119,998,536         | 70,840           | 1.86                     |
| Livestock and crop marketings               | 17,987,172           | 174,343          | 5.46                     | 18,819,729       | 259,457          | 4.99                     | 110,811,835         | 65,417           | 1.91                     |
| All Government farm payments                | 907,894              | 8,800            | 6.51                     | 953,018          | 13,139           | 7.73                     | 3,357,712           | 1,982            | 3.39                     |
| Other farm income                           | 694,169              | 6,728            | 12.44                    | 1,028,082        | 14,174           | 8.54                     | 5,828,989           | 3,441            | 4.87                     |
| Operating expense less interest             | 15,176,157           | 147,097          | 6.23                     | 16,735,312       | 230,720          | 4.40                     | 94,831,773          | 55,983           | 1.88                     |
| Interest paid on real estate debt           | 1,166,696            | 11,308           | 6.82                     | 1,437,319        | 19,816           | 6.15                     | 7,561,326           | 4,464            | 2.43                     |
| Interest paid on operating loans            | 1,151,771            | 11,164           | 5.98                     | 1,398,366        | 19,279           | 5.91                     | 5,977,568           | 3,529            | 2.44                     |
| Net cash income                             | 2,094,610            | 20,302           | 20.39                    | 1,229,831        | 16,955           | 41.87                    | 11,627,868          | 6,864            | 9.14                     |
| Off-farm income                             | 1,525,204            | 14,783           | 27.02                    | 1,064,065        | 14,945           | 9.12                     | 27,194,061          | 16,054           | 6.77                     |
| Farm family income                          | 3,619,814            | 35,086           | 16.71                    | 2,313,896        | 31,900           | 22.92                    | 38,821,929          | 22,918           | 5.29                     |
| Total farm debt                             | 20,368,531           | 197,425          | 5.46                     | 23,528,990       | 324,381          | 5.31                     | 120,078,131         | 70,887           | 2.11                     |
| Total farm assets                           | 73,620,078           | 713,572          | 5.15                     | 104,411,599      | 1,439,464        | 5.18                     | 546,687,910         | 322,732          | 1.83                     |
|                                             |                      |                  |                          |                  | Percent          |                          |                     |                  |                          |
| Debt/asset ratio                            | na                   | 28               | 4.13                     | na               | 23               | 5.80                     | na                  | 22               | 1.95                     |
| Asset turnover ratio                        | na                   | 24               | 3.97                     | na               | 18               | 5.21                     | na                  | 20               | 1.81                     |
| Fixed asset turnover ratio                  | na                   | 29               | 4.38                     | na               | 21               | 5.63                     | na                  | 23               | 1.94                     |
| Ratio of interest to total cash expense     | na                   | 13               | 5.12                     | na               | 14               | 4.05                     | na                  | 12               | 1.71                     |
| Ratio of off-farm income to net cash income | na                   | 73               | 33.25                    | na               | 88               | 31.56                    | na                  | 234              | 11.51                    |

na = not applicable.

<sup>1</sup> Average per farm represents the mean per reporting farm in the sample except for the case of ratios where they are sectoral averages. The coefficient of variation is defined as the standard deviation divided by the mean.

Source: (8).

number of farm operations. The probability-based FCRS provides the opportunity to state the accuracy of estimates and to examine and evaluate the sample size. By comparison, in the nonprobability COPS, USDA chose sample sizes using subjective criteria; the sample was drawn from a core of cooperative farmers, and statistical accuracy could not be objectively measured.

The physical and investment characteristics of the farm operation are also included in the FCRS (fig. 2). In part I, for example, enumerators ask each farm respondent for information on general farm characteristics. Farm expenses and income items are recorded in part II and include: whole farm expenses by type or category; land use; crop acreages and yields; livestock inventory, sales, purchases, and feed use; crop receipts, inventory, and so forth; and farm business and financial characteristics. Part III represents the modular sections that are used to obtain specific detailed technical and other farm- or household-related information. This detailed information can then be related to general farm characteristics because of the subsampling procedures which are based on preselection with known probabilities. Such detailed data collection procedures provide primary survey data on particular types or categories of farm business and farm households, their organizational characteristics, and their operating or technical practices.

Several repercussions will occur with the new survey approach. We will have more rigid, formal, and complex procedures both when conducting the survey and when using the data. We will also be able to evaluate and report on the accuracy of the data so that data users can evaluate their reliability for other analytical purposes.

### **Distributional Indicator Data Series: Enhancing the Aggregate Perspective**

The ability to focus analyses on certain types and kinds of operations was perhaps unimportant when the farm sector was composed of several million farms, mostly small and reliant on agriculture for family income. Relative homogeneity within the sector meant aggregate measures could be used to discuss economic well-being of the component subsectors.

However, agriculture has become increasingly and noticeably heterogeneous. As a result, aggregate economic accounts and data series, constructed in the absence of distributional considerations, have become increasingly ineffective in providing insight into the well-being of various farm subpopulations. Sundquist illustrated this point in 1970 by arguing that "...there seems to be little merit in speaking of average income, average problems, or average anything for . . . units . . . classified as farms" (12).

The difficulty of using averages to represent commercial and noncommercial operations, various legal organizations, tenure groups, or commodity subsectors becomes particularly acute when the analyses are focused on the distributional consequences of agricultural and economic policy and on financial conditions (7). Johnson and Short have suggested that "using aggregate sales or production data to assess distribution of information requires a strong assumption, often untenable, about class composition" (4). This viewpoint will probably become increasingly important for future agricultural policy and research efforts.

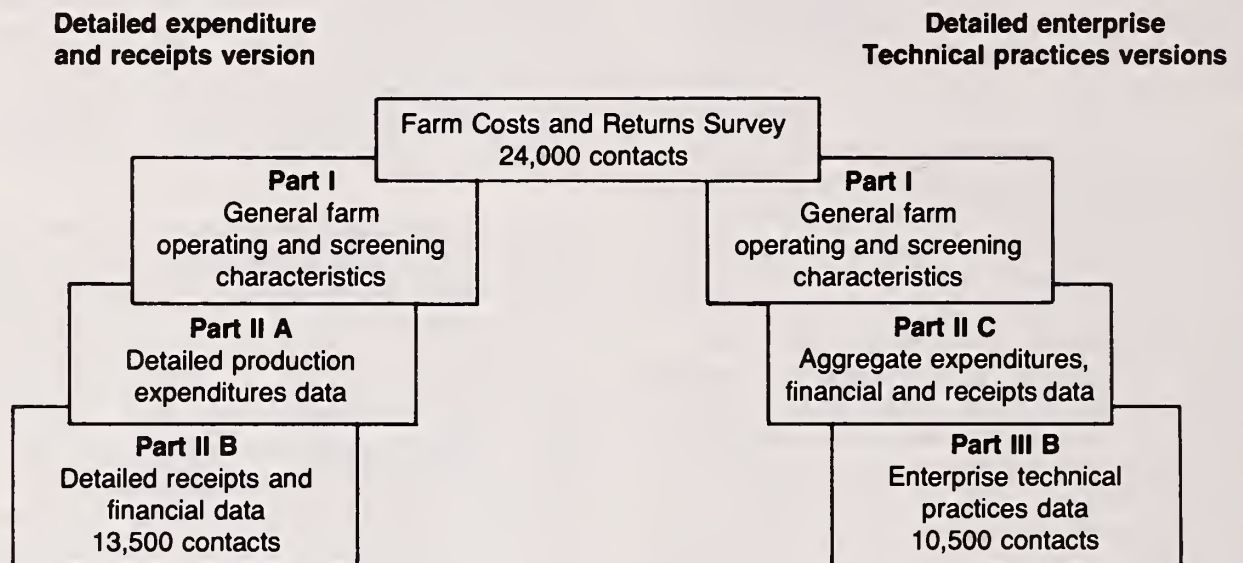
USDA designed the 1984 FCRS to provide financial characteristics of the farm business, sales, operator occupation and off-farm income, production, capital expenditure, and Government-program participation in addition to the usual expense data. For example, the data in table 2 were derived from the 1984 FCRS and demonstrate conclusively that producers in the differing acreage classes varied substantially with regard to every operating characteristic shown. Even a superficial analysis of these data strongly suggests that conclusions reached using just aggregate data for policy or program purposes would probably be misleading or incorrect.

This point is made even more emphatically by the data on the sources and uses of cash income of farms producing corn (table 3). Corn farmers' level and sources of gross cash income vary considerably by region. Expenses, especially interest paid, also vary considerably by region. Farmers growing corn show net operating margins ranging from a large positive to a large negative. Moreover, the level of farm business leverage and off-farm income varies considerably. This variation illustrates the difficulty in using aggregate sector data to estimate either the

Figure 2

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## The Farm Costs and Returns Survey: FY 1985



Part I: Screening and general farm operating characteristics:

- Land use
- Crop acreages, yields, and so forth
- Farm business and financial organization

Part II: Farm production expenditures, receipts, and financial data, including items such as:

- Whole-farm expenses by type or category
- Livestock inventory, sales, and purchases
- Crop receipts, inventory, and so forth
- The farm business balance sheet

Part III: Modular sections for specific detail

- A. Detailed information needs for special and key variables and data items relating to production activities and whole farm expenses
  - B. Data on particular types or categories of farm organizational characteristics and technical practices used in crop and livestock production
-

Table 3—Sources and uses of cash income on farms producing corn, by region, 1984<sup>1</sup>

| Item                                                | Northeast               | Lake States | Corn Belt | Northern Plains | Appalachia | Southeast | Delta   | Southern Plains | Mountain States | Pacific States | All regions |
|-----------------------------------------------------|-------------------------|-------------|-----------|-----------------|------------|-----------|---------|-----------------|-----------------|----------------|-------------|
|                                                     | <i>Number</i>           |             |           |                 |            |           |         |                 |                 |                |             |
| Sample size                                         | 610                     | 997         | 1,450     | 427             | 748        | 258       | 92      | 81              | 342             | 174            | 5,179       |
| Expanded number of farms                            | 59,104                  | 140,733     | 227,522   | 62,159          | 81,569     | 29,017    | 6,716   | 8,171           | 10,051          | 4,354          | 629,396     |
| Expanded share of all farms (percent)               | 9                       | 22          | 36        | 10              | 13         | 5         | 1       | 1               | 2               | 1              | 100         |
|                                                     | <i>Dollars per farm</i> |             |           |                 |            |           |         |                 |                 |                |             |
| Livestock sales                                     | 74,977                  | 54,029      | 43,756    | 65,459          | 37,857     | 26,545    | 32,776  | 66,536          | 129,774         | 302,493        | 52,912      |
| + Crop sales                                        | 16,065                  | 25,127      | 49,093    | 54,979          | 32,009     | 53,637    | 31,550  | 83,440          | 60,211          | 257,412        | 41,087      |
| = Cash sales                                        | 91,042                  | 79,156      | 92,850    | 120,438         | 69,866     | 80,182    | 64,326  | 149,976         | 189,985         | 559,906        | 93,999      |
| + Government payments                               | 985                     | 2,290       | 1,739     | 4,667           | 806        | 1,386     | 2,233   | 4,683           | 3,361           | 8,053          | 2,056       |
| = Other cash income                                 | 1,923                   | 2,566       | 2,746     | 6,885           | 2,269      | 1,665     | 788     | 5,907           | 9,598           | 19,961         | 3,174       |
| = Gross cash income                                 | 93,949                  | 84,012      | 97,335    | 131,990         | 72,940     | 83,232    | 67,348  | 160,566         | 202,944         | 587,920        | 99,230      |
| - Interest paid                                     | 6,852                   | 11,676      | 11,696    | 16,454          | 6,180      | 7,913     | 8,262   | 18,638          | 26,851          | 61,060         | 11,454      |
| = Net operating expenses                            | 72,775                  | 62,624      | 67,947    | 99,099          | 53,884     | 77,089    | 61,760  | 162,850         | 186,566         | 478,423        | 74,785      |
| = Net operating margin                              | 14,323                  | 9,712       | 17,692    | 16,436          | 12,876     | -1,770    | -2,674  | -20,922         | -10,472         | 48,437         | 12,990      |
| + Off-farm income                                   | 7,773                   | 11,943      | 12,452    | 4,563           | 12,721     | 11,248    | 11,045  | 13,370          | 4,170           | 10,237         | 10,949      |
| = Total cash available                              | 22,095                  | 21,655      | 30,144    | 21,000          | 25,597     | 9,478     | 8,372   | -7,551          | -6,303          | 58,674         | 23,939      |
| - Family Living expenses                            | 12,950                  | 12,950      | 12,950    | 12,950          | 12,950     | 12,950    | 12,950  | 12,950          | 12,950          | 12,950         | 12,950      |
| - Principal payments                                | 5,718                   | 9,431       | 9,226     | 11,404          | 4,385      | 5,825     | 7,153   | 15,264          | 18,185          | 45,494         | 8,823       |
| = Cash balance                                      | 3,427                   | -726        | 7,969     | -3,355          | 8,262      | -9,297    | -11,731 | -35,765         | -37,437         | 230            | 2,165       |
| Total value of owned assets                         | 345,531                 | 352,885     | 364,383   | 457,304         | 274,629    | 314,489   | 302,005 | 548,960         | 911,793         | 1,384,211      | 372,813     |
| Total value of debt                                 | 66,492                  | 109,663     | 107,275   | 132,606         | 50,988     | 67,734    | 83,174  | 177,488         | 211,452         | 528,998        | 102,598     |
|                                                     | <i>Percent</i>          |             |           |                 |            |           |         |                 |                 |                |             |
| Debt/asset ratio                                    | 19.24                   | 31.08       | 29.44     | 29.00           | 18.57      | 21.54     | 27.54   | 32.33           | 23.19           | 38.22          | 27.52       |
| Debt as a share of U.S. debt                        | 6.09                    | 23.90       | 37.80     | 12.77           | 6.44       | 3.04      | 0.87    | 2.25            | 3.29            | 3.57           | 100.00      |
| Assets as a share of U.S. assets                    | 8.70                    | 21.17       | 35.33     | 12.11           | 9.55       | 3.89      | 0.86    | 1.91            | 3.91            | 2.57           | 100.00      |
| Balance as a share of cash sales                    | 3.76                    | na          | 8.58      | na              | 11.83      | na        | na      | na              | na              | .04            | 2.30        |
| Balance as a share of total assets                  | .99                     | na          | 2.19      | na              | 3.01       | na        | na      | na              | na              | .02            | .58         |
| Share of farms with negative or zero cash balance   | 58.01                   | 48.50       | 47.04     | 55.51           | 45.60      | 57.63     | 77.92   | 70.78           | 58.86           | 45.79          | 50.35       |
| Share of farms participating in Government programs | 16.53                   | 37.03       | 37.17     | 55.82           | 23.21      | 19.22     | 18.30   | 15.65           | 29.44           | 31.74          | 33.77       |

na = not applicable, because cash balance is negative.

<sup>1</sup>Data may not add because of rounding.

solvency, liquidity, or profitability of a business or the probable effects of policy adjustments on a particular segment of the industry.

Other cross-classifications can be developed from the FCRS to enhance financial analyses of the farm business establishments. Because these data are based on a multiframe probability sample of nearly 24,000 farms, reliable national and regional estimates are easily obtained. Other distributionally related microeconomic indicators can be organized by size (such as acreage or sales class), occupation, tenure, or farm business organization. Of course, when the data are disaggregated to provide a disaggregated perspective, thin data in a specific individual cell are possible. When this situation occurs, thin data estimates should be used only as a guide to the characteristics of farms in the subpopulation rather than as a precise estimate.

To reduce the incidence of thin data cells, USDA has recommended an increase in funding. This funding would also allow USDA to expand the FCRS sample size so that reliable aggregate data can be obtained at the State level. These aggregate data would allow multiple-dimension cross-tabulations at the national and regional levels. Moreover, the expanded survey would provide sample data that can be used to develop more disaggregated national perspectives of changing conditions in the farm sector by type, size, and other characteristics.

## Conclusions

Aggregate agricultural statistics and indicators have long served as measures of economic well-being of the farm sector. In the future, economic indicators will need to be disaggregated to be useful for policy and program analysis. To meet this demand for different farm-sector data and for information better describing changing economic conditions, USDA merged the previously conducted FPES and COPS into a new and broader economic survey, the FCRS.

The FCRS is an integrated, probability-based, annual national whole farm survey conducted to improve both aggregate and disaggregate economic indicators needed by Government officials as well as by farmers and others who make decisions that affect the farm sector. The resulting data set includes detailed information on financial characteristics, expenses,

receipts, resource base, and production practices on farms. To be even more useful, the FCRS will also provide other socioeconomic data such as age, education, and off-farm income. These data will allow not only more accurate estimates of farm-sector income but also a better grasp of income distribution among sector participants, while contributing to our goals of maintaining conceptual clarity, flexibility, and progressive adaptability for the future.

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Over the years, the price of human time has risen greatly relative to that of the services of natural resources. Real hourly wages in the United States were more than five times as high in 1972 as they were in 1900, whereas the real price of the commodities most dependent on natural resources tended not to rise.

*Theodore W. Schultz*  
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# Money and Agriculture: The Dynamics of Money-Financial Market-Agricultural Trade Linkages

By David Orden\*

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## Abstract

This article investigates empirical relationships among the money supply, the interest rate, the exchange rate, the general price level, and agricultural exports and relative prices using three- and six-variable vector autoregressive models. Shocks to the money supply have little direct effect on agriculture, whereas positive interest rate, exchange rate, and general-price-level shocks have negative effects. The dynamic patterns characterizing monetary interactions with the financial variables do not preclude the possibility that monetary policies underlie the observed interest rate and exchange rate impacts, but the observed price-level shocks appear to be independent of the money supply. Agricultural exports and prices demonstrate little impact on the macroeconomic variables.

## Keywords

Macroeconomic-agricultural linkages, exchange rate effects on agriculture, inflation and agriculture

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## Introduction

This article investigates macroeconomic impacts on agriculture. The analysis focuses on relationships among the money supply, the interest rate, the exchange rate, the general price level, and agricultural exports and relative prices. These relationships are central to recent discussions of macroeconomic-agricultural linkages, but they remain imperfectly

understood. To help clarify the interactions among these variables, I use three- and six-variable vector autoregressive (VAR) models in which quarterly data are viewed as generated by own- and cross-variable dynamic responses.

Several issues arise at the outset. First, assessing macroeconomic impacts on agriculture is elusive despite the importance of these impacts to both private decisionmakers and agricultural policymakers. This ambiguity is due in part to the diversity of plausible conceptual approaches that have been suggested about macroeconomics and linkages from macroeconomics to agriculture. Thus, one of my objectives is to review some of these approaches.

A second set of issues concerns the use of VAR models in economic analysis. Given the diversity of theories suggested to characterize macroeconomic-agricultural linkages and the empirical evidence marshaled to support each of them, it seems appropriate to examine the historical evidence to see which views are consistent with past experience before imposing a particular model. VAR models

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offer one useful approach to such an analysis. VAR models can help us clarify theoretical and empirical controversies over these linkages and can help us evaluate the potential effects of alternative policies. VAR models also provide a basis for assessing the importance of alternative sources of instability in the agricultural sector, and they can help us with economic forecasting.

Considerable mystery has surrounded the recent use of VAR models for these purposes, and their use remains controversial. The mystery arises primarily from a general lack of familiarity among applied economists with the analytic techniques, diagnostics, and standard methods of reporting associated with VAR models. The controversy arises over whether appropriate characterizations of economic dynamics are provided by these models and whether policy interpretations can be associated with their outcomes.

Because of the importance of these issues, I also describe some of the mechanics of VAR modeling and the basic controversies concerning their interpretation. My objective is to help readers unfamiliar with VAR models place the empirical results in an appropriate perspective, not to break new ground in methodology.<sup>1</sup>

Following the sections on methodology, I specify a six-variable empirical model of macroeconomic-agricultural linkages. I compare dynamic interactions in the six-variable model with those in a simpler model restricted to the money supply, agricultural exports, and agricultural prices. Although the agricultural variables seem largely independent of money in the restricted model, shocks to the financial market variables and the general price level have substantial impacts on agriculture. Alternative theoretical perspectives are evaluated in light of this evidence.

## Theoretical Perspectives

The agricultural sector has long had an interest in relationships between agriculture and the rest of the

economy. With the rapid expansion of trade during the seventies, this attention centered on the impact of the exchange rate on agricultural exports and prices. Early analytic and empirical studies focused on the effects of a currency realignment, taken as exogenous, on the domestic and foreign prices of a specific commodity and on the equilibrium quantity traded (6, 15). Later, it was recognized that potential cross-price effects arise from the simultaneous impact of an exchange rate realignment on the prices of many commodities (5, 18). The additional effects of income shifts associated with changes in the real exchange rate have recently been recognized (20).

Because exchange rates are a crucial transmission mechanism by which macroeconomic factors bear on agricultural trade, and thus on U.S. agriculture overall, it is not surprising that many recent empirical studies have focused directly on measuring these impacts. Refining our estimates of key parameters and furthering our knowledge of conceptual issues related to these impacts are important in quantifying these effects. Furthermore, when the exchange rate moves markedly, as it has over the past few years, the consequences for agriculture are of concern to the sector regardless of the underlying causes of the exchange rate realignment. That is, the exchange rate itself is the macroeconomic variable of interest for some purposes.

However, policy analysis cannot progress far without an understanding of the factors that underlie movement of variables such as the exchange rate. Isolating policy-induced movements in these variables is crucial. Following the pioneering work by Schuh (22), this effort has focused on the impacts of monetary and fiscal policies. With flexible exchange rates and well-integrated international capital markets, Schuh argues, tight monetary policy and/or expansionary fiscal policy induces a capital inflow and an appreciation of the currency (23). Agriculture and other trade sectors bear the brunt of policy adjustment as exports decline and imports rise.<sup>2</sup>

By focusing attention on monetary and fiscal policies, Schuh and others generalize the issue of

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<sup>1</sup>In presenting a case for the utility of VAR analysis, I will leave it to others to present alternative views. This omission is by no means intended to deny the importance of the controversy. Interested readers should see (3, 7, 12). Italicized numbers in parentheses refer to items in the References at the end of this article.

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<sup>2</sup>Though Schuh has been instrumental in calling attention to the potential effects of monetary and fiscal policies on agriculture, his articles (24, 25) place the impact of these policies in a broad context.

macroeconomic impacts on agriculture in two important respects. First, macroeconomic policies may affect agriculture through many mechanisms other than the exchange rate. Potential policy effects through interest rates, national incomes, international liquidity, and other facets of the economy need to be taken into account. Second, and perhaps more important, the evaluation of macroeconomic impacts on agriculture confronts the contemporary issue in macroeconomic theory of whether, and if so, when, macroeconomic policies have real impacts. Establishing a link from macroeconomic policy to agriculture requires establishing avenues by which macroeconomic policies affect the economy. Alternative models suggest quite different perspectives on this issue.

Two viewpoints illustrate some of the basic macroeconomic controversies. In the first, the economy is viewed in terms of a stochastic equilibrium model in which all prices are flexible, agents have rational expectations, and markets clear. In such a model, anticipated changes in the money supply have known effects on nominal income and proportionate effects on individual prices and the general price level. Hence, real economic activity is not affected. An unanticipated monetary shock, in contrast, is partly confused with shifts in relative demand, and it induces output responses. If price elasticities of supply and demand differ across markets, a monetary shock may affect relative prices and have different impacts among sectors. Thus, in a stochastic equilibrium model, changes in the money supply can have real impacts, but policymakers may be unable to exploit these effects systematically to influence developments in the economy.

An alternative to the market-clearing equilibrium model is an approach in which some prices are less than perfectly flexible for some medium-length period.<sup>3</sup> Commodities fall into one of two categories: fixed-price or flex-price. Two crucial characteristics then distinguish the fixed-price/flex-price model from the stochastic equilibrium model. First, even anticipated monetary policy may have real effects because of the inability of some prices to adjust in the short run. Second, macroeconomic policies may

cause excessive price movements (price overshooting) in flex-price markets where the burden of policy impact is initially absorbed. A key result is that expansionary monetary policy, though inflationary, may benefit agriculture as flexible agricultural prices rise faster than the overall price level. Rausser has characterized this overshooting in response to expansionary monetary policy as a subsidy to the agricultural sector (21).

The study of market structure has produced a third view of the effects of inflation on agriculture. The market structure approach, like the fixed-price/flex-price macroeconomic model, is characterized by a dichotomy between flexible agricultural prices and administered (that is, fixed) industrial prices. In this view, increases in input and other industrial prices arising in oligopolistic or price-setting industries are not necessarily passed on to agricultural output prices, which are determined in competitive markets (29). Rising industrial prices place agriculture in a cost-price squeeze, so farmers experience a decline in relative prices during inflationary periods. This is just the opposite of what happens in the fixed price/flex-price macroeconomic model.

One can understand the discrepancy between these latter two views of the effects of inflation on agriculture in terms of alternative assumptions about the causes of price changes and the behavior of the monetary authorities. In the fixed-price/flex-price model, monetary expansion causes inflation and the associated upward overshooting of agricultural prices. In the market structure approach, an increase in administered industrial prices causes relative agricultural prices to fall. This exogenous price shock is associated implicitly with inflation, but the linkage of rising administered prices to the money supply and monetary policy is not precise. Such an autonomous price shock arising in the fixed-price sector could also generate both inflation and a decline in flexible prices relative to fixed prices in a fixed-price/flex-price macroeconomic model.

Opposed to each of the preceding analyses—which, despite their differences, center on responses of the agricultural sector to developments arising outside the sector—is a fourth line of reasoning concerning macroeconomic-agricultural linkages. It focuses on agriculture as a source of instability within the overall economy. This concern was particularly acute

<sup>3</sup>See (8) for a further discussion of stochastic equilibrium models and (21) for a review of the literature on fixed-price/flex-price models.

in the early seventies when food and oil prices were explosive (2, 11, 30). From this perspective, explaining relative agricultural price movements as a function of general price movements may have cause and effect exactly reversed. Models in which exogenous macroeconomic developments are assumed to affect agriculture, with impacts from agriculture on the macroeconomy precluded, are called into question.

## Vector Autoregressive Models

Vector autoregressive econometric analysis begins with selecting a set of variables perceived as relevant to an economic issue under investigation. These variables may be transformed to remove nonlinearity, trend, or seasonal components. The modeling begins with estimation of a set of regression equations in which the current value of each variable is expressed as a function of lagged values of the selected variables. No variable is assumed to be exogenous *a priori*, and no variable is excluded from the autoregressive equation for any other variable. Because each autoregressive equation has the same right-hand-side regressors, ordinary least squares (OLS) provides an efficient estimation procedure.

Regression analysis is quite familiar and, were analysis of VAR models to proceed on the basis of the estimated autoregressive equations, it too would be familiar. However, when there are no exogenous variables, the regression equations do not have a natural interpretation. The autoregressive parameters explain how each variable evolves through time, given past values of the variables in the model. But the usual types of analysis, such as determining the effect of an exogenous change in an independent variable on the dependent variable, are unnatural when all right-hand-side variables themselves evolve in a way specified by the estimated equations.

A more natural approach to a VAR model is to distinguish between the expected evolution of the economy (represented by the autoregressive parameters) and the deviations from this evolution occurring over time as a result of unexpected shocks. These shocks are measured by the error terms of the autoregressive equations. One can evaluate interactions among variables in a VAR model by examining the effects of these errors on the subsequent evolution of all variables in the model.

To accomplish this task, one transforms the estimated autoregressive equations to derive a moving-average representation of the VAR. This transformation may be viewed as the outcome of a sequence of substitutions in which lagged values of right-hand-side variables are replaced by their own autoregressive equation. Each substitution backdates the values of actual variables that appear in the initial equation by one period and introduces errors from an additional lag.

To illustrate, consider the transformation of a two-variable, one-lag autoregressive model:

$$\begin{aligned}x_t &= d_{11}x_{t-1} + d_{12}y_{t-1} + e_t \\y_t &= d_{21}x_{t-1} + d_{22}y_{t-1} + h_t\end{aligned}\tag{1}$$

where the expected values of  $e_t$  and  $h_t$  are zero and the errors are not serially correlated. If one considers just the  $x$  variable, the first step of the transformation to the moving-average representation is:

$$\begin{aligned}x_t &= d_{11}(d_{11}x_{t-2} + d_{12}y_{t-2} + e_{t-1}) \\&\quad + d_{12}(d_{21}x_{t-2} + d_{22}y_{t-2} + h_{t-1}) + e_t\end{aligned}\tag{2}$$

Continuing this process, one derives:

$$\begin{aligned}x_t &= e_t + a_{11}e_{t-1} + \dots + a_{21}h_{t-1} + a_{22}h_{t-2} + \dots \\y_t &= b_{11}e_{t-1} + \dots + h_t + b_{21}h_{t-1} + b_{22}h_{t-2} + \dots\end{aligned}\tag{3}$$

where the  $a_{ij}$ 's and  $b_{ij}$ 's are nonlinear combinations of the autoregressive parameters ( $d_{ij}$ 's).<sup>4</sup>

An advantage of the moving-average representation compared with the autoregressive equations is that the coefficients of the moving-average representation describe exactly how a shock to a particular variable at one moment in time shifts the expected time path of each variable in the model compared with its expected evolution had the shock not occurred. For example, in equations (1) - (3), the effect of a one-unit shock to variable  $y$  at time  $t-1$  on  $x_t$  is  $a_{21}$  and on  $y_t$  is  $b_{21}$ , while the effect of a shock to  $y$  at time  $t-2$  on

<sup>4</sup>The autoregressive and moving-average representations can be expressed compactly in matrix notation. See (13) for a good discussion of the methodology.

$x_t$  is  $a_{22}$  and on  $y_t$  is  $b_{22}$ . Likewise, the effect of a shock to  $y$  at time  $t$  on the expected value of some future  $x$ , say  $x_{t+i}$ , is given by  $a_{2i}$ , and so on. Thus, the coefficients of the moving-average representation provide impulse response functions that trace either how current values of each variable are affected by shocks in the past or how expected future values of each variable are affected by a shock today. These impacts are intractable in the autoregressive parameters because a specific shock has both direct and indirect effects on the evolution of each variable. Notice too that the effects of a specific shock are computed assuming no additional shocks occur. Hence, the impulse response functions describe changes induced by an initial shock assuming all variables then evolve naturally, rather than holding all else constant in the usual sense.

The moving-average representation also provides a second useful measure of the impacts of the variables in the model on one another. Future values of each variable are forecast assuming all future shocks have their expected value of zero. Because these shocks are random, the variance of these forecasts can be computed. The variance for each forecast can then be apportioned or decomposed into components due to each variable. This decomposition is based on the variance of the shocks to each variable (estimated from the error terms of the autoregressive equations) and the impacts of these shocks on each forecast (estimated by the coefficients of the moving-average representation). Such a decomposition provides a preliminary assessment of dynamic interactions among the variables.

One complication that often arises is that the errors associated with specific variables (for example,  $e_t$  and  $h_t$  in equations (1) - (3)) are contemporaneously correlated. Cross-product terms in the forecast variance expressions then make it impossible to decompose forecast error variances. The usual procedure in this case is to choose a particular ordering of the variables in the model and to remove from the shock to each variable that portion which is explained by contemporaneous shocks to variables earlier in the chosen order. This procedure of orthogonal ordering is equivalent to including the current value of variables earlier in the order on the right-hand-side of autoregressive equations for variables that follow. This procedure imposes a recursive causality on the variables selected for analysis. A particular order

must be chosen as part of the specification of the model, and altering the order may affect estimates of the dynamic relationships among the variables. Hence, examining models with alternative orthogonal orders provides a guide to interpreting reported outcomes and is a useful test of the robustness of specific results.

## Interpretation of VAR Models

The preceding discussion clarifies some of the mechanics of VAR models. Their interpretation in economic analysis and their use in policy evaluation raise a related, but somewhat different, set of issues. Because there are no exogenous variables in a VAR model, each variable potentially affects all other variables. This generality is appealing in cases where several plausible theories have been suggested concerning the economic dynamics, but it precludes usual identification of a structural model.<sup>5</sup>

The moving-average representation of a VAR model focuses the analysis on the error terms associated with the autoregressive equations; own- and cross-variable dynamic impacts of these shocks are evaluated. Interpreting a VAR model depends on connecting each of these shocks to a specific variable in the economy. Usually such a connection is made between the equations of a structural model and specific variables. The autoregressive equations from a VAR model are equivalent to the reduced-form equations from such a structural model. But when a reduced form is derived from a structural model, the reduced-form errors are generally linear combinations of the errors from the structural equations. Thus, no direct association is made between these errors and specific aspects of the economy.

Under special circumstances, dynamic effects of shocks associated with VAR equations will exactly match those of shocks to equations of a structural model. This situation occurs when the structural

<sup>5</sup>Formal arguments favoring this approach to econometric modeling have been presented by Sims (27). He suggests that a structure based on *a priori* exogeneity and exclusion restrictions is rarely justified. His argument is based on the relatively small number of distinctions that imply appealing restrictions, the difference between exogenous and lagged endogenous variables with respect to structural identification when lag length and serial correlation are not known, and the effects of expectations on the behavior of economic agents, which tend to undermine potential exclusion restrictions.

model is diagonal (only lagged values of other variables enter the structural equation for each variable) or when the structural model is recursive and the orthogonal ordering of the VAR model exactly matches this recursive order.

The true model of the aspects of the economy under investigation is, of course, rarely known and will not necessarily satisfy the diagonal or recursive criterion. Impulse response functions from a VAR model may then misrepresent the dynamics of shocks to the true structural equations. Likewise, estimates of the dynamic effects of shocks to a misspecified structural model will also misrepresent the true dynamics.<sup>6</sup> The fundamental controversy over using VAR models in economic analysis is based on this dilemma. Using a VAR model rests on the conviction that important dynamics in the economy are usefully captured by its moving-average representation.

## A Model of Money, Financial Markets, and Agriculture

To provide some empirical insights into the relationships among money, financial market variables, inflation, and agriculture, I specified a six-variable VAR model. Variables in the model were: (1) the seasonally adjusted U.S. money supply (M1), (2) the interest rate on 3-month Treasury bills, (3) a trade-weighted index of the value of the dollar (\$\*/\$) against the currencies of 10 industrial countries, (4) the general price level as measured by the U.S. gross national product (GNP) deflator, (5) the value of U.S. agricultural exports, and (6) agricultural prices as measured by the index of prices received by farmers for all crops. I estimated the autoregressive parameters of the model using quarterly data from 1960(1) through 1984(3) without allowing for parameter variation during the estimation period. Four lags of each variable were included in the autoregressive equations; each autoregressive equation also included constant, trend, and seasonal terms. I evaluated all variables, except the interest rate, in natural logarithms. To account for contemporaneous correlations among the errors, I orthogonalized the model initially in the order in which these six variables appear. This order allows the greatest opportunity for macroeconomic factors to affect agriculture, and not vice versa. This order also

allows the greatest possible influence for the money supply variable.

I estimated the parameters of the model reported here using nominal values of the interest rate, the exchange rate, the value of agricultural exports, and the index of crop prices. An alternative approach is to deflate these nominal values prior to estimation. Using a deflated model is appealing for this analysis because real changes can be expected to be important among sectors of the economy. However, constructing deflated values prior to estimation moves the analysis away from variables that are directly observable. One result is to entangle the dynamics of price-level effects with the effects of other variables.<sup>7</sup> Furthermore, one can generally derive the real effects of specific shocks from the model estimated in nominal terms by subtracting the simultaneous effects of various shocks on the price level from their effects on other nominal variables.<sup>8</sup> The results from a nominal model are also more directly comparable with those from macroeconomic VAR models in which construction of deflated variables has generally been avoided.

Table 1 shows the R-squares and standard deviations of errors associated with the autoregressive equations from the six-variable, macroeconomic-agricultural model. Table 2 reports the results of F-tests for the null hypotheses; coefficients on lags associated with particular variables are zero in each of the autoregressive equations. Table 2 shows the probability of the corresponding (but not reported) F-statistic occurring if the null hypothesis were true.

The F-tests in table 2 have several implications. First, they show substantial evidence of macroeconomic impacts on agriculture. Lagged exchange rates are significant in the equation for agricultural exports, and lags of all four macroeconomic variables are significant in the equation for agricultural prices. There is also evidence of complex interactions

<sup>7</sup>In a related paper (19), I presented the results from a model estimated using an *ex post* real interest rate, a real trade-weighted exchange rate, and deflated values of agricultural exports and prices. Interested readers may want to compare the two sets of outcomes. The key conclusions from the analysis are supported by comparable results from the two approaches to estimation.

<sup>8</sup>The derivation is not possible for the exchange rate unless the nominal model includes an index of foreign price levels.

<sup>6</sup>See (1) and (14) for a further discussion.

**Table 1—Measure of fit and standard deviation of the errors, autoregressive equations, six-variable macroeconomic-agricultural model**

| Variable             | R-square | Standard deviation of errors |
|----------------------|----------|------------------------------|
| Money supply (M1)    | 0.9998   | 0.00465                      |
| Interest rate        | .9568    | .63926                       |
| Exchange rate        | .9732    | .01914                       |
| Price level          | .9999    | .00268                       |
| Agricultural exports | .9907    | .07698                       |
| Agricultural prices  | .9908    | .03719                       |

among the macroeconomic variables. Lagged values of both the money supply and the interest rate are significant in the money supply and interest rate equations, and lags of three of the four macroeconomic variables are significant in the exchange rate equation. In contrast, only own lags are significant in the price-level equation. Effects of the agricultural variables are not significant in the equations for the macroeconomic variables.

Table 3 shows the decomposition of variance for forecasts 4 and 12 quarters ahead for the six-variable

model. Table 3 also shows the decomposition of forecast variance for a three-variable model that includes only the money supply, the value of agricultural exports, and the index of crop prices. This comparison is particularly relevant in light of past observations that the explanatory power of money supply shocks in a three-variable macroeconomic model (money supply, real output, and the price level) is reduced substantially in expanded models that also include financial variables such as the interest rate.<sup>9</sup> One might also compare the results from the restricted model with other recent studies of macroeconomic-agricultural linkages in which the money supply is the only macroeconomic variable included in the analysis (4, 10).

<sup>9</sup>Sims reports that the money supply variable appears largely exogenous in a three-variable VAR model with real gross national product (GNP) and the price level (that is, own shocks explain 81 percent of its forecast error variance at 14 quarters ahead) and that money shocks explain a large fraction of the variance in forecasts of real output in this model (28). A positive monetary shock induces a temporary rise in output and a slower, steady rise in the price level. These results are consistent with short-run real effects of monetary shocks in a stochastic equilibrium model and with the hypothesis that instability in monetary policy has been a prime cause of price and output movements in the economy. In autoregressive models that include financial variables, however, the role of money shocks is substantially reduced (26, 28). Much of the explanatory power of money in the three-variable model is transferred to the interest rate.

**Table 2—Significance of the lags of each variable, autoregressive equations, six-variable macroeconomic-agricultural model**

| Dependent variable   | Lagged variables                             |               |               |             |                      |                     |
|----------------------|----------------------------------------------|---------------|---------------|-------------|----------------------|---------------------|
|                      | Money supply                                 | Interest rate | Exchange rate | Price level | Agricultural exports | Agricultural prices |
|                      | <i>Significance level of the F-statistic</i> |               |               |             |                      |                     |
| Money supply (M1)    | *                                            | *             | 0.306         | 0.890       | 0.767                | 0.480               |
| Interest rate        | <b>0.024</b>                                 | *             | .484          | .103        | .725                 | .862                |
| Exchange rate        | .112                                         | *             | *             | .037        | .784                 | .144                |
| Price level          | .151                                         | 0.396         | .743          | *           | .775                 | .244                |
| Agricultural exports | .558                                         | .767          | *             | .081        | .255                 | *                   |
| Agricultural prices  | *                                            | <b>.006</b>   | *             | <b>.004</b> | .137                 | *                   |

Boldface indicates cases for which there is evidence for rejecting the null hypothesis at the 95-percent confidence level.

\* indicates a significance level of less than 0.001.

**Table 3—Decomposition of 4- and 12-quarters-ahead forecast error variances, three-variable and six-variable macroeconomic-agricultural models**

| Variable             | Quarters ahead | Shocks to—                                |               |               |             |                      |                     |
|----------------------|----------------|-------------------------------------------|---------------|---------------|-------------|----------------------|---------------------|
|                      |                | Money supply                              | Interest rate | Exchange rate | Price level | Agricultural exports | Agricultural prices |
|                      | <i>Number</i>  | <i>Percent of forecast error variance</i> |               |               |             |                      |                     |
| Money supply         | 4              | 60.3                                      | 36.1          | 0.2           | 1.4         | 1.5                  | 0.5                 |
|                      | 12             | 44.1                                      | 36.0          | 1.5           | 9.6         | 1.5                  | 7.3                 |
|                      | 4              | (98.4)                                    |               |               |             | (2.3)                | (4.3)               |
|                      | 12             | (65.6)                                    |               |               |             | (6.1)                | (28.3)              |
| Interest rate        | 4              | 39.4                                      | 55.7          | .7            | 2.4         | 1.3                  | .5                  |
|                      | 12             | 23.8                                      | 28.4          | 22.6          | 8.2         | 1.1                  | 15.9                |
| Exchange rate        | 4              | 3.7                                       | 30.8          | 58.4          | 3.7         | 1.1                  | 2.3                 |
|                      | 12             | 15.8                                      | 34.6          | 42.2          | 3.8         | .6                   | 3.0                 |
| Price level          | 4              | 14.3                                      | 1.7           | 3.6           | 78.1        | 1.3                  | 1.0                 |
|                      | 12             | 10.5                                      | 23.9          | 34.1          | 25.6        | 1.4                  | 4.5                 |
| Agricultural exports | 4              | 3.0                                       | 4.8           | 12.2          | 9.7         | 55.6                 | 14.7                |
|                      | 12             | 12.0                                      | 36.9          | 22.7          | 5.4         | 17.3                 | 5.7                 |
|                      | 4              | (2.5)                                     |               |               |             | (86.9)               | (10.6)              |
|                      | 12             | (2.1)                                     |               |               |             | (87.7)               | (10.2)              |
| Agricultural prices  | 4              | 1.8                                       | 13.3          | 2.3           | 8.5         | 16.0                 | 58.1                |
|                      | 12             | 8.5                                       | 38.2          | 9.8           | 16.2        | 5.5                  | 21.8                |
|                      | 4              | (9.8)                                     |               |               |             | (37.5)               | (52.7)              |
|                      | 12             | (8.8)                                     |               |               |             | (56.7)               | (34.5)              |

Numbers in parentheses indicate decomposition of forecast error variances for a three-variable model.  
Blanks indicate not applicable.

In the three-variable macroeconomic-agricultural model, own shocks explain almost all the variance in 4-quarter-ahead forecasts of the money supply; a substantial fraction of this variance in a 12-quarter forecast horizon is explained by shocks to agricultural prices. Shocks to agricultural exports have little effect on the forecast error variance for money.

Despite the relatively large proportion of own forecast error variance explained by shocks to the money supply in the three-variable model, money shocks have only slight effects on the forecast error variance of the agricultural exports and price variables. Indeed, agricultural exports appear largely exogenous, whereas shocks to exports have a substantial impact on the variance of agricultural price forecasts. These results seem to suggest the importance to agriculture of sectoral, rather than macroeconomic, factors.

When the interest rate, the exchange rate, and the price level are added to the three-variable model, the effects of money shocks on agricultural exports and relative prices remain relatively small. Three important new results emerge, however.

First, the proportion of own forecast error variance explained by money shocks declines, and money shocks affect the forecast error variance for the interest rate and the exchange rate. These results are consistent with outcomes from macroeconomic models that include financial variables (9, 28). The interest rate and the exchange rate have a strong interaction in the macroeconomic-agricultural model. Their shocks jointly explain over 50 percent of the variance in interest rate forecasts 12 quarters ahead and over 70 percent of the variance in exchange rate forecasts 12 quarters ahead.

Second, the fraction of forecast error variance of the agricultural variables explained by sectoral shocks falls substantially. Own shocks explain only 17.3 percent of the 12-quarter-ahead forecast error variance of agricultural exports in the six-variable model, compared with 87.7 percent in the three-variable model. Likewise, agricultural export and price shocks explain only 5.5 percent and 21.8 percent, respectively, of the variance of 12-quarter-ahead agricultural price forecasts (compared with 56.7 and 34.5 percent, respectively, in the three-variable model). Most of the lost explanatory power is absorbed by the interest rate and the exchange rate, in the case of agricultural exports, and by the interest rate and the price level, in the case of agricultural prices.

Third, the decomposition of forecast error variance for the six-variable model suggests very limited effects of the two agricultural variables on the forecast error variances of the macroeconomic variables. The proportion of M1 forecast error variance attributable to agricultural price shocks is reduced compared with the three-variable model, and the agricultural variables explain little of the forecast error variance for the additional macroeconomic variables. These results are invariant to placement of the agricultural variables ahead of the macroeconomic variables in the orthogonal order.

Some further insight into the economic dynamics is provided by the impulse response functions for the three- and six-variable models. In the three-variable model (not shown), a money supply shock declines slowly over eight quarters. A shock to agricultural exports has negligible effects on the money supply, but a shock to agricultural prices is followed by a steady decline in the expected money supply. Money supply and agricultural price shocks have positive effects on expected agricultural exports, but these impacts are slight compared with a 1-standard-deviation export shock. The export shock has a positive effect on agricultural prices that peaks four quarters later at a level about equal to a 1-standard-deviation price shock. A money supply shock also positively affects agricultural prices peaking with a four-quarter lag, but the magnitude of this impact is small compared with the impacts of price and export shocks.

The figure shows the impulse response functions from the six-variable model. Each column indicates the responses of one variable over eight quarters to

an initial 1-standard-deviation positive shock to each of the six variables. Thus, by looking down a column, one can assess the relative impact on a particular variable of various shocks typical of those estimated to have occurred during the sample period. For the interest rate, the value of agricultural exports, and the index of crop prices, the real effects of each shock are shown in the figure (that is, the simultaneous effects of each shock on the price level have been removed from their effects on the nominal values of these variables).

One can observe several aspects to the dynamic interactions among macroeconomic variables shown in the figure. A positive shock to the money supply declines slowly and steadily raises the price level. A money supply shock is also followed by a modest, but fairly persistent, rise in the interest rate. In contrast, an interest rate shock affects the expected interest rate for a relatively short period. It is followed by a decline in the money supply, a persistent appreciation of the U.S. dollar, and a lagged decline in the price level. Shocks to the exchange rate and the price level tend to persist, but have negligible effects on the money supply and the interest rate.<sup>10</sup>

The impulse response functions for the agricultural variables also show significant cross-variable interactions. In particular, the figure illustrates several macroeconomic impacts on agriculture. Money supply shocks have only small effects on the value of agricultural exports and relative agricultural prices, but an interest rate shock has an effect on exports which peaks with a magnitude about 50 percent of that of an export shock itself. An interest rate shock

<sup>10</sup>The contemporaneous correlation between shocks to the interest rate and the exchange rate is 0.45. Thus, it is probably appropriate to view these two variables as jointly representing financial markets. Specific effects attributed to one or the other of these variables should be interpreted cautiously. For example, the decomposition of forecast error variance shown in table 3 and the impulse responses shown in the figure suggest that interest rate shocks have substantial effects on the exchange rate. If the exchange rate is placed ahead of the interest rate in the orthogonal order, however, the proportion of exchange rate forecast error variance 12-quarters-ahead which is explained by own shocks rises to 70.5 percent, whereas the proportion explained by interest rate shocks falls to 6.3 percent. Likewise, the response of the exchange rate to an interest rate shock is dampened considerably. Other dynamic interactions among the macroeconomic variables remain similar to those displayed in the figure, although the effect of an exchange rate shock on the price level is greater.

has a somewhat larger lagged effect on agricultural prices.<sup>11</sup> Shocks to the price level also noticeably affect agriculture. An unexpected increase in the price level has a strong negative effect on relative agricultural prices.

The dynamic interactions displayed in the figure have several implications in terms of the alternative views of macroeconomic-agricultural linkages. Except for the fairly large effect of a money supply shock on the interest rate, there is only slight evidence of direct impacts from the money supply on either the financial market variables or the agricultural sector variables. If one views the money supply variable as a policy instrument of the monetary authorities, then the empirical results show little evidence that monetary policy affects agriculture.<sup>12</sup> Direct effects on agriculture of shocks to financial variables, particularly the interest rate, are more evident.

One possibility is that financial variables are very sensitive to expectations and move quickly in response to a shift in monetary policy. If changes in monetary policy are correctly anticipated and if these expectations are reflected in shocks to the financial variables before they are reflected in reported monetary aggregates, then monetary policy could still be the driving force behind the observed data patterns. This possibility requires that anticipated monetary policy have real effects, a proposition consistent with the fixed-price/flex-price macroeconomic model, but not with the stochastic equilibrium model. Furthermore, this view suggests that particular dynamic patterns should appear in the data. For example, an increase in the interest rate that correctly reflects an anticipated tightening of the money supply should be followed by such tightening and, perhaps, by a decline in the rate of inflation. Failure to observe these results has caused some

macroeconomic studies to reject this possibility (17, 26). However, responses to interest rate shocks in some macroeconomic studies (9) and responses to interest rate and exchange rate shocks in the figure support this interpretation.

With respect to the general price level, the impulse responses shown in the figure do not suggest that price-level shocks arise in response to anticipated monetary policy (that is, the figure does not suggest that anticipated monetary expansion causes prices to rise now). Price-level shocks are not followed by changes in the money supply, and they cause relative agricultural prices to fall without an initial increase. These results are consistent with the view that autonomous price increases in nonagricultural sectors place agriculture in a cost-price squeeze, but not with the notion of monetary-induced inflation and overshooting of flexible agricultural prices (in which case one might expect a positive price-level shock to be associated with an initial increase in relative agricultural prices and to be followed by an increase in the money supply).

Finally, with respect to agriculture as a source of instability in the overall economy, neither the decomposition of variance nor the impulse response functions from the six-variable model demonstrates substantial macroeconomic impacts arising from the agricultural export and price variables. These outcomes are not altered appreciably when the agricultural variables are placed before the macroeconomic variables in the orthogonal order. This result suggests that macroeconomic-agricultural linkages are primarily from macroeconomic developments to agriculture, not vice versa.

## Conclusions

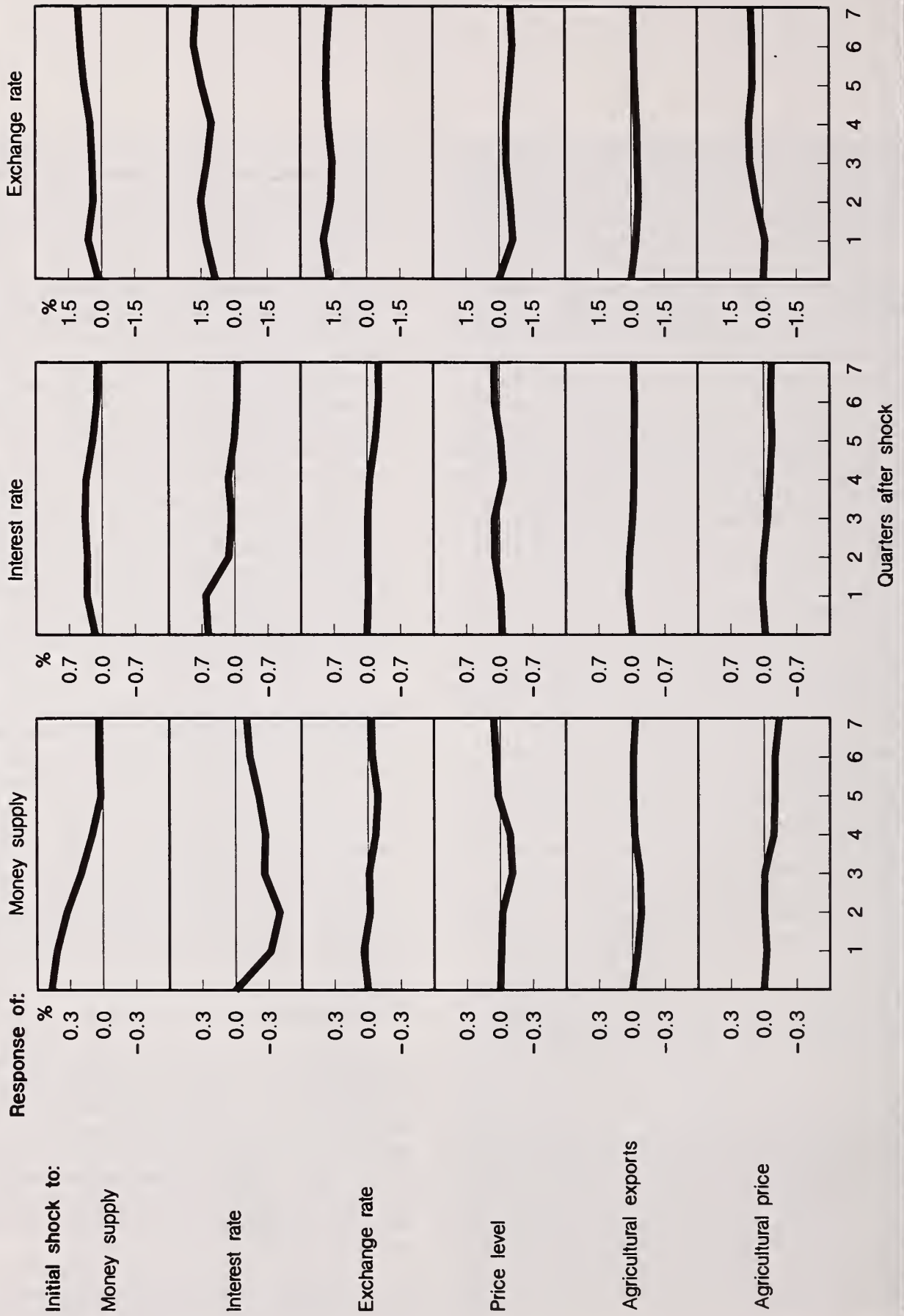
The relationships among monetary and agricultural variables have been at the center of recent discussion of macroeconomic impacts on agriculture. Even so, definitive empirical evaluation of specific linkages has remained elusive. In this article, I have specified three- and six-variable VAR models and evaluated interactions among the money supply, the interest rate, the exchange rate, the general price level, and agricultural exports and relative prices.

The results suggest that there may be good reason for the ambiguity that characterizes discussion of

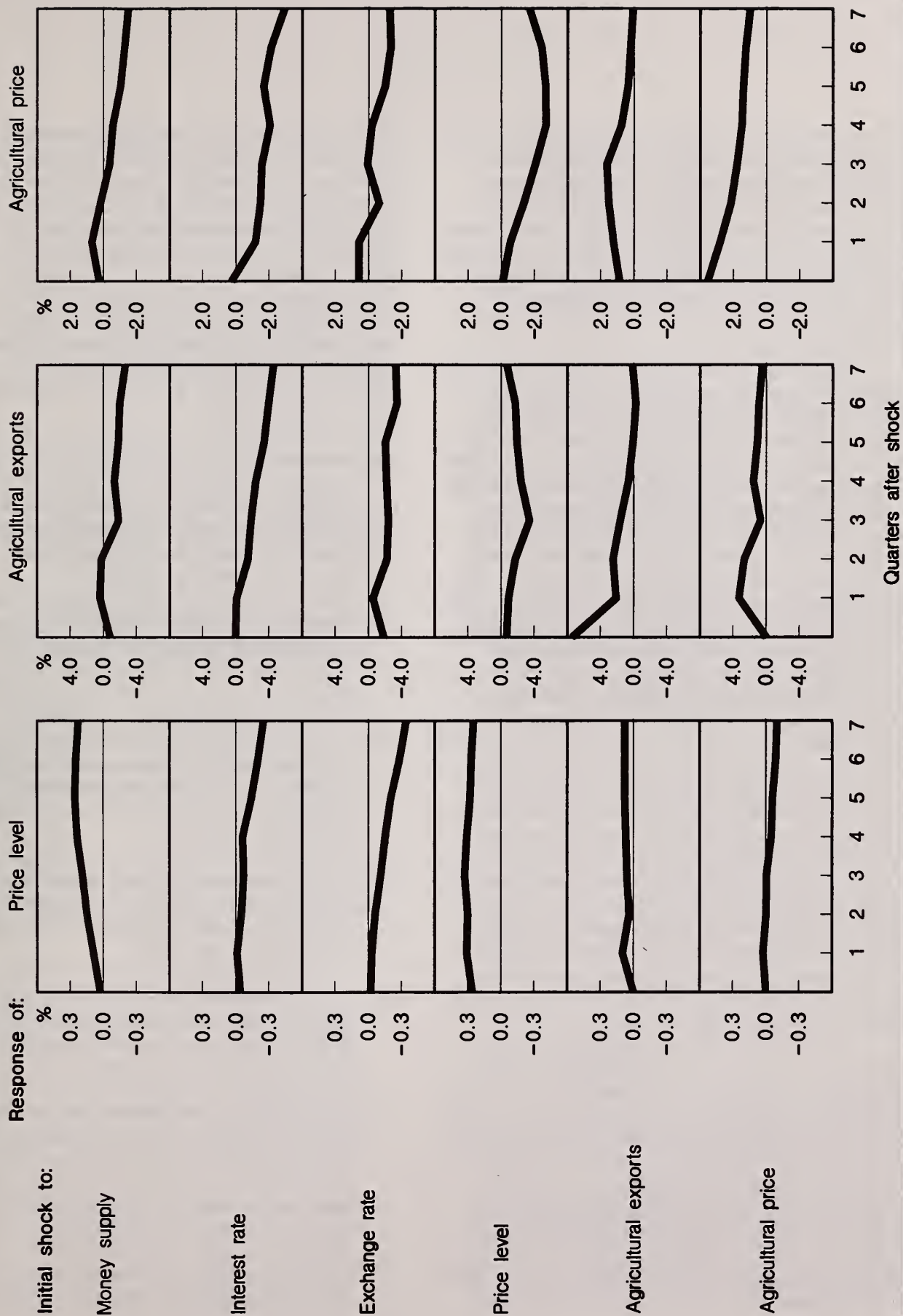
<sup>11</sup>In the results displayed in the figure, an exchange rate shock has a small effect on agricultural exports and little effect on agricultural prices. Again, these results are sensitive to the orthogonal order. When the exchange rate precedes the interest rate, the effects of an exchange rate shock on the agricultural variables exceed those of an interest rate shock. An unexpected appreciation of the dollar depresses subsequent agricultural exports and prices.

<sup>12</sup>Somewhat greater effects of money supply shocks on relative agricultural prices are suggested by a model estimated in deflated terms (see 19).

# **Impulse Response Functions, Six-Variable Macroeconomic-Agricultural Model**



# Impulse Response Functions, Six-Variable Macroeconomic-Agricultural Model



macroeconomic-agricultural linkages. Several linkages among macroeconomic and agricultural variables are isolated, and a number of these are quite important. In particular, there is strong evidence both for the effects of financial variables on agricultural exports and prices and for the effects of autonomous changes in the price level. In contrast, there is little evidence of impacts on the macroeconomic variables arising from shocks to agricultural exports or prices.

Specific shocks are associated with specific variables in a VAR model. Interpreting the results of these models as a basis for policy analysis must rest on this association of errors and variables, on the ability of policymakers to manipulate specific variables, and on such manipulation not affecting the estimated parameters of the model. One interpretation of the results I have presented is that shocks associated with financial markets (that is, the interest rate and the exchange rate) are independent of policy intervention. From this point of view, monetary policy does not have powerful effects on agricultural exports or relative prices. Autonomous financial market shocks have greater effects on agriculture, but are not subject to control by macroeconomic policymakers.

An alternative interpretation of the results is that monetary authorities may induce interest rate or exchange rate shocks through the instruments they control. This control could be exerted directly or because changes in monetary policies affect financial market variables before they are recorded in money stock data.<sup>13</sup> In either case, the impact of monetary policy on agricultural exports and prices would be more pervasive than under the first interpretation. Dynamic responses in the VAR model are consistent with the latter possibility.

This point is clear when one applies similar considerations to the price-level variable. Price-level shocks could also reflect monetary decisions. In that case, one would expect an increase in the price level

to affect agricultural prices like a decline in the interest rate. This situation does not occur, suggesting a different interpretation: price shocks not associated with monetary policy depress relative agricultural prices. This interpretation is consistent with the hypothesis of agriculture's being caught in a cost-price squeeze, but not with the hypothesis of monetary-induced overshooting of flexible agricultural prices. Such an outcome does not fit easily into recent analysis of the disinflationary effects of tight monetary policy and its specific effects on agriculture. Even so, the data display strong evidence of such a phenomenon.

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<sup>13</sup>Litterman treats the Federal funds rate as an indicator of monetary policy and evaluates the impacts of changes in this rate on the money supply, other financial variables, and the real economy (16). A change in the Federal funds rate is assumed to affect the 3-month Treasury bill rate, stock prices, and the value of the dollar contemporaneously, but to affect the money supply only after a 1-month lag.

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Nonfarm families typically have higher money incomes than farm families but lower net worths. Considerable public money is channeled into the farm sector via farm commodity programs, directly affecting the level of well-being as measured here. Economists often argue that many of the benefits from farm programs get capitalized into land values and thus may affect the level of net worth more than money income. This is because benefits are tied directly to land resources rather than family need. If these programs were expanded until the level of money income of farm families equaled that of nonfarm families, the economic well-being of farm families might well exceed that of the nonfarm group. From society's point of view, it may be more desirable to provide direct income support to families in the farm sector than to further enhance the level of net worth.

*Thomas A. Carlin*  
*July 1973, Vol. 25, No. 3*

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# Research Review

## Crop Insurance for Agricultural Development: Issues and Experience

Peter Hazell, Carlos Pomareda, and Alberto Valdés (eds.).  
Baltimore: Johns Hopkins Press, 1986, 322 pp., \$32.50.

By David Freshwater and David Trechter\*

Many countries operate "multi-peril" crop insurance programs to compensate participating farmers when various environmental factors cause low yields. This book leaves one with the overwhelming impression that multi-peril crop insurance has been an expensive failure. The book, although primarily oriented toward crop insurance programs in developing countries, also examines crop insurance in developed economies. In both environments multi-peril crop insurance has received large government subsidies, serviced a limited clientele, and had marginal success in stabilizing farm income. This book addresses both theoretical arguments for establishing crop insurance (including potential impacts on producer and lender incentives) and historical experiences with such insurance. Roughly half the book has a theoretical or conceptual focus; the other half is devoted to case studies of particular programs.

Although each chapter is written by a different author or authors, the editors have done a good job of referring the reader to other chapters containing relevant material. The introductory and concluding chapters, written by the editors, provide a useful overview and briefly summarize major arguments and conclusions. Anyone with even a passing interest in the economics of multi-peril crop insurance should read these chapters.

The book has several shortcomings. The papers are grouped into three parts, one focusing on demand for crop insurance, one dealing with insurance as a policy instrument, and one examining the operation of selected crop insurance programs. The part examining insurance as a tool for policy is by far the least successful. It is not clear why some of the chapters are even in this section. In particular, the chapters on crop insurance programs in Mexico and Japan might better have been placed in the empirical part of the book. The biggest disappointment

of this section, however, is that it fails to deal positively with the shortcomings of crop insurance. If crop insurance is a flawed tool, what changes could be made to improve its performance? If it is an inappropriate policy tool, are there alternatives that address the same objectives? The authors address such questions, if at all, in a superficial and unconvincing way. For example, the conclusion of the chapter analyzing Mexico's program states that crop insurance "increases incomes and employment in the farm sector and prevents a decline in aggregate production. Perhaps these effects might more simply be attained through price policy." But is this alternative politically feasible? Can a price policy also address other problems, such as stability of income or improved access to credit, which motivate crop insurance programs? The authors generally prefer to list alternatives without submitting them to the same degree of scrutiny given to the crop insurance program.

The other sections of the book are more successful. The authors tend to focus on a few common themes: (1) crop insurance works best as a mechanism to stabilize farm income when the principal factor affecting income is yield fluctuations; (2) multi-peril crop insurance schemes are expensive to operate and subject to moral hazard and adverse selection;<sup>1</sup> and (3) subsidized crop insurance programs may provide net social benefits, but may not be the most efficient means of achieving social goals. Conversely, crop insurance programs are considered useful in well-defined contexts, such as insuring yields against specific natural hazards. This technique can also be an effective way to foster the development of credit for farmers, since it protects lenders against a major cause of borrower default, particularly if the lender receives the crop insurance payment directly.

<sup>1</sup>When insurance coverage alters a policyholder's incentive structure such that outcomes involving losses are encouraged, a moral hazard exists. Adverse selection arises when farmers with higher than average risks comprise a larger share of the insurance pool than forecast when premiums were set.

\*The reviewers are agricultural economists with the Agriculture and Rural Economics Division, ERS.

Those with an interest in U.S. agriculture will find the chapter by Gardner and Kramer particularly useful. It gives an account of the development of the U.S. crop insurance program, summarizes previous studies of program impacts, and analyzes demand for crop insurance and its influence on farmer behavior. Other chapters use U.S. examples in their analysis. In his chapter on the financial viability of agricultural insurance, Pomerada examines the U.S. experience in terms of administrative costs, indemnity to coverage ratios, and other operating variables.

By focusing attention on all-risk crop insurance and the problems encountered with its use in developing countries, the book leaves the impression that crop insurance is a flawed tool. However, the inevitability of this conclusion is unclear. Many problems described in the book arise either because crop insurance is asked to serve a function for which it is not well suited or because the information necessary for successful implementation is not available. The book does contain much useful information. Better organization and a more comprehensive analysis in the policy section would have enhanced it greatly.

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Instead of mounting surpluses, increasing storage costs, and Treasury expenditures for farm commodity programs, rising consumer food costs have become a principal concern of people interested in U.S. agricultural policy. Associated with this changed emphasis is a renewed interest in foreign trade policy for agricultural commodities and the effects of liberalized trade on the U.S. food and fiber sector of the economy.

*James Vermeer, David W. Culver,  
J.B. Penn, and Jerry A. Sharples  
April 1975, Vol. 27, No.2*

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# Linking Macroeconomic and Agricultural Policies for Adjustments with Growth: The Colombian Experience

Vinod Thomas and others. A World Bank Publication.  
Baltimore and London: Johns Hopkins Press,  
1985, 252 pp., \$32.50.

Reviewed by H. Christine Bolling\*

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The author and his collaborators are the World Bank's "old hands" on Colombia's economy and have produced several excellent World Bank reports. Using material taken from some of these publications, the authors have presented a study that is both a technically excellent and very readable account of Colombia's macroeconomic and agricultural policies and their effects. Any students of Colombia's agriculture should read this book.

The authors make several background points:

- Colombia has a relatively small modern sector superimposed on a broad traditional base. It produces more than 90 percent of its own food, and agriculture is still a major industry.
- Nearly half of Colombia's legal foreign exchange earnings are from coffee exports. Colombia has diversified from coffee to protect itself from the wide swings characteristic of a primary product economy. [But, in 1986, coffee will again provide the windfall foreign exchange earnings that will pull Colombia out of its current economic slump. Colombia's economic boom of the late seventies was also due to a runup in international coffee prices.]
- Colombia has a low foreign debt at a time when its neighbors, both rich and poor, have suffered the consequences of carrying a large debt load. Colombia's current debt situation is largely attributed to its conservative import policy.
- Colombia is a textbook case for policymakers because, at one time or another, the Government has tried nearly every type of intervention: exchange rate manipulation, import taxes, export taxes, export subsidies, import licensing, and price controls through the Instituto de Mercadeo Agropecuario (Agricultural Marketing Institute (IDEMA)).

The book provides an analytical account of Colombia's policies. Some of the problems that Colombia has had to deal with are universal to developing countries: devaluation, inflation, and the vagaries of primary product markets. Because Colombia has gotten through these problems more successfully than most developing countries, its experiences may be an object lesson to others.

The authors stress that policymakers cannot make agricultural policy in isolation, nor can the macroeconomic policymakers ignore the effect their decisions have on the farm sector. They often must make tradeoffs among sectors, and they may find themselves in a web of offsetting policies.

In the chapter on export policy, the authors cover exchange rate management (through the "crawling peg" exchange rate), export loans, and subsidies. They conclude that Colombia has benefited more from an export-oriented policy than from import substitution.

In the import policy chapter, the authors develop a rationale for import tariffs and licensing. They then show how these instruments cause increased domestic prices, inefficient allocation of resources, and losses in consumer welfare. They also show the tradeoffs among policies. For example, higher tariffs are used to compensate for overvaluation of the peso. With a higher tariff, the importable sector grows partly at the expense of the exportable sector. Moreover, increases in protection tend to depress overall economic activity. The authors also note that trade liberalization should proceed in stages to reduce short-term dislocation (many policymakers choose to ignore this point).

The latter chapters pertain specifically to agriculture. The authors use the price intervention chapter to discuss the role of IDEMA in Colombia's agricultural price-support program.

The chapter on price stabilization is less country-specific. Although price stabilization is a goal of Col-

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\*The reviewer is an agricultural economist with the International Economics Division, ERS.

Colombia's agricultural policy, the authors say that it is often unclear whether Colombia's policies stabilize prices, incomes, or some other economic factor. Price stabilization may bring other problems: distortions in production incentives and a failure to react to price signals in world markets.

Coffee gets a special chapter because of its importance to Colombia's economy. Although coffee exports raised export earnings, these windfall earnings had to be carefully managed to avoid excessive inflation. The authors discuss current coffee production technology and the policy issues specific to coffee: export taxes, mandatory deposits of export receipts in the Central Bank, stock and price policy, and diversification programs.

Other chapters include Government expenditures on agriculture and input policies. Finally, the authors sum up how these policies, whose aim is "to bring about economic adjustment while sustaining growth," are faring. They show what policy issues Colombia will face in the near term.

The authors have written this book cleverly. Although they use empirical studies, they leave the mathematical modeling for the appendixes and footnotes. Several of these appendixes are worthy of mention. Appendix A showcases economic models that support the authors' conclusions on the interaction of coffee prices, money supply, and inflation in Colombia. Models in appendix B illustrate how changes in international coffee prices affect the competitiveness of coffee with other import goods and nontradables in Colombia.

Appendix C contains a model for predicting nominal interest rates in a semi-industrialized, semi-open

country like Colombia with explanatory variables of money supply, real income, expected devaluation of the domestic currency, and a risk premium term. Appendix F details Colombia's marketing system for coffee, emphasizing the price mechanism and coffee taxes. Other appendixes graphically present the welfare cost of price stabilization and measure variability in international, producer, and consumer prices, producer gross incomes, and net profits for nine crops.

The book has a few minor weaknesses. In discussing protection and efficiency (p. 68), the authors take the easy way out in the calculation of nominal rates of protection by comparing farm gate with international prices for several commodities and then by noting in the text how prices should be more precisely identified. The authors are long-time students of Colombian agriculture and presumably have more access to price, transportation cost, and marketing cost information than do most researchers.

One of the contributing authors states: "it is necessary to increase the real quantity of money, requiring that an increase in the rate of growth in nominal money not be matched by higher equiproportional inflation (pp. 190-91). This feat can be accomplished in the real world economy only in the very short run. Although the authors criticize the Colombian coffee industry for carrying too large a stock, the country will benefit from windfall profits from that stock. In early 1986, the Brazilian coffee industry suffered crop losses from drought, driving up international prices. Such is the fate of an author's putting prediction into print. These criticisms aside, the book is a worthwhile study of considerable breadth and depth.

# Removal of Price Supports and Supply Controls for U.S. Tobacco: An Economic Analysis of the Impact

Daniel A. Sumner and Julian M. Alston, Washington, D.C.:  
National Planning Association, 1985, 60 pp. \$8.00

Reviewed by Barbara Stucker\*

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Sumner and Alston have tackled a touchy subject: the consequences of removing price supports and supply controls for U.S. tobacco. The authors deserve credit for examining this sacred cow of farm commodity programs. In their own words, "Elimination or phasing out of the federal tobacco program would have impacts on the prices and quantities of several products and would significantly affect the income and well-being of millions of people." Their analysis does not address the social issues and controversy over the conflicting Federal policies of farm support and public health. Theirs is not a social assessment of a shift in policy away from price supports and supply controls; it is an economic analysis of the change in the well-being of producers, the tobacco industry, and exporters. The book analyzes changes in prices, supply, and demand for tobacco that might result if protectionism were abolished or reduced.

The book begins with an extremely brief description of the U.S. tobacco program. Fifty years of history are condensed to a single page. No criticism is intended here, simply an observation that the authors are anxious to get into the analysis without becoming bogged down in historical legislation. They concentrate on the current program and its operation. They explain supply controls and support prices with the right degree of depth to give the reader a good understanding of the tobacco program and its peculiarities, but not in such detail as to slow the reader down.

Tobacco is a peculiar crop, and that's what makes this economic analysis unique. The authors must unravel a tangle of restrictions on producing and marketing tobacco before they can assess the "good and bad" of deregulation. They begin by examining who owns production rights—that is, how many quota holders produce tobacco, as opposed to how many producers lease the right to raise tobacco. Patterns of ownership vary by State, as do lease rates, occupation of owners, size of quotas, and number of allotments.

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\*The reviewer is an agricultural economist with the National Economics Division, ERS.

The authors then continue to wave their economic wands over the tobacco sector, eliminating price supports here, withdrawing allotments there, and voilà: Equilibrium is achieved, production expands, prices fall, exports rise, demand increases domestically, efficiency is attained in least-cost regions, and industry revenues bulge. Areas of expansion are blessed with increased income, whereas losers experience the contractionary costs of dislocation and lost income.

Perhaps the hand is quicker than the eye in this case. Of course, a change in price vis-a-vis a reduction in price supports would affect supply and demand. So would freedom of production. These are not enlightening results. But the degree of change presented by the authors is of such magnitude that both their results and the questions raised by those results are worth mentioning here:

- An increase in tobacco production of 50-100 percent,
- A reduction in the price of tobacco of 20-30 percent,
- An increase of 100 percent in U.S. tobacco exports,
- An increase in the quantity of U.S. tobacco demanded by 50-100 percent, and
- An increase of 15-60 percent or more in total revenue to the tobacco industry.

Aren't any negatives associated with deregulation of the tobacco industry? Yes, the authors illuminate them as well:

- A loss of up to 2-3 percent in personal income in counties with a high dependence on income from quota ownership,
- Elimination of the capital value of tobacco production rights and the consequent loss of about \$800 million in annual income to quota owners,

- Major costs of dislocation and disruption if price supports and production restrictions were eliminated suddenly, and
- Some increase in price variability for tobacco relative to the 1950-80 period.

The results of the analysis elicit the question: why is deregulation dragging its feet, when the consequences seem to fit so well with current overall farm policy objectives? Despite the negative consequences associated with deregulation, they are negative mostly for landowners who, we should be reminded, are largely not the producers. Expansion in production that would be absorbed by regaining lost export markets is a dominant theme of farm policy in the eighties; here is a case where that policy could be successfully implemented.

The authors caution against immediate and swift deregulation for several reasons. First, postulating what the tobacco industry would look like in the absence of regulations is like painting a picture blindfolded. Tobacco has been regulated in varying degrees for more than half a century. No one can be sure of the results of deregulation, because no one has seen such an animal. It is no longer the tobacco industry of the thirties. Thus, the authors admit their confidence must be checked on this score.

Next, even if policymakers wished to redistribute wealth from nonfarming landowners to producers, the loss of wealth to individuals, to counties, and to regions which have come to depend on that wealth would be enormous, highly concentrated in a few areas, and devastating. Tobacco quota ownership is most concentrated in North Carolina, for example, providing over 5 percent of the State's total agricultural revenue. One county alone in North Carolina would, according to deregulation proposed here, lose

\$19 million, or about 14 percent of its total revenue from agriculture. When policymakers are faced with an equally pressing concern of alleviating financial stress, as they certainly have been thus far in the eighties, the gains from deregulation pale somewhat.

Still, the authors offer a compromise: phase out price supports and supply controls, if immediate deregulation is economically and otherwise unpalatable. The tradeoffs between slow and swift, they suggest, are smaller costs of disruption and smaller losses to quota owners at the expense of other people who would benefit from immediate elimination.

This book concludes with two reviews: one from a representative of the tobacco industry (James H. Starkey, Vice President of Universal Leaf Tobacco Company, Inc.), the other from a veteran agricultural economist (Harold F. Breimyer). Although both reviews commend the authors for their undertaking, the reviewers less than fully embrace the results of tobacco deregulation. Starkey suggests that the single biggest problem with the tobacco program is price, which has hampered the ability of U.S. tobacco to compete in world trade and led to disillusionment with the tobacco program on all fronts. Breimyer concedes the problems of the tobacco program, but also admits remembering the pre-1933 years, when "tobacco farmers were probably agriculture's poorest in the years just before the program began. Tobacco production was the refuge of the impoverished. Entry was so easy, jobs so scarce, and acreage so expandible." Breimyer concludes, as does this reviewer, that by exploring various issues in program-making for tobacco, Sumner and Alston have provided a useful service. Given the path on which U.S. agriculture is currently headed, policymakers can only welcome analyses that consider changes in farm commodity programs designed to speed agriculture on its path to recovery and strong performance in the years ahead.

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